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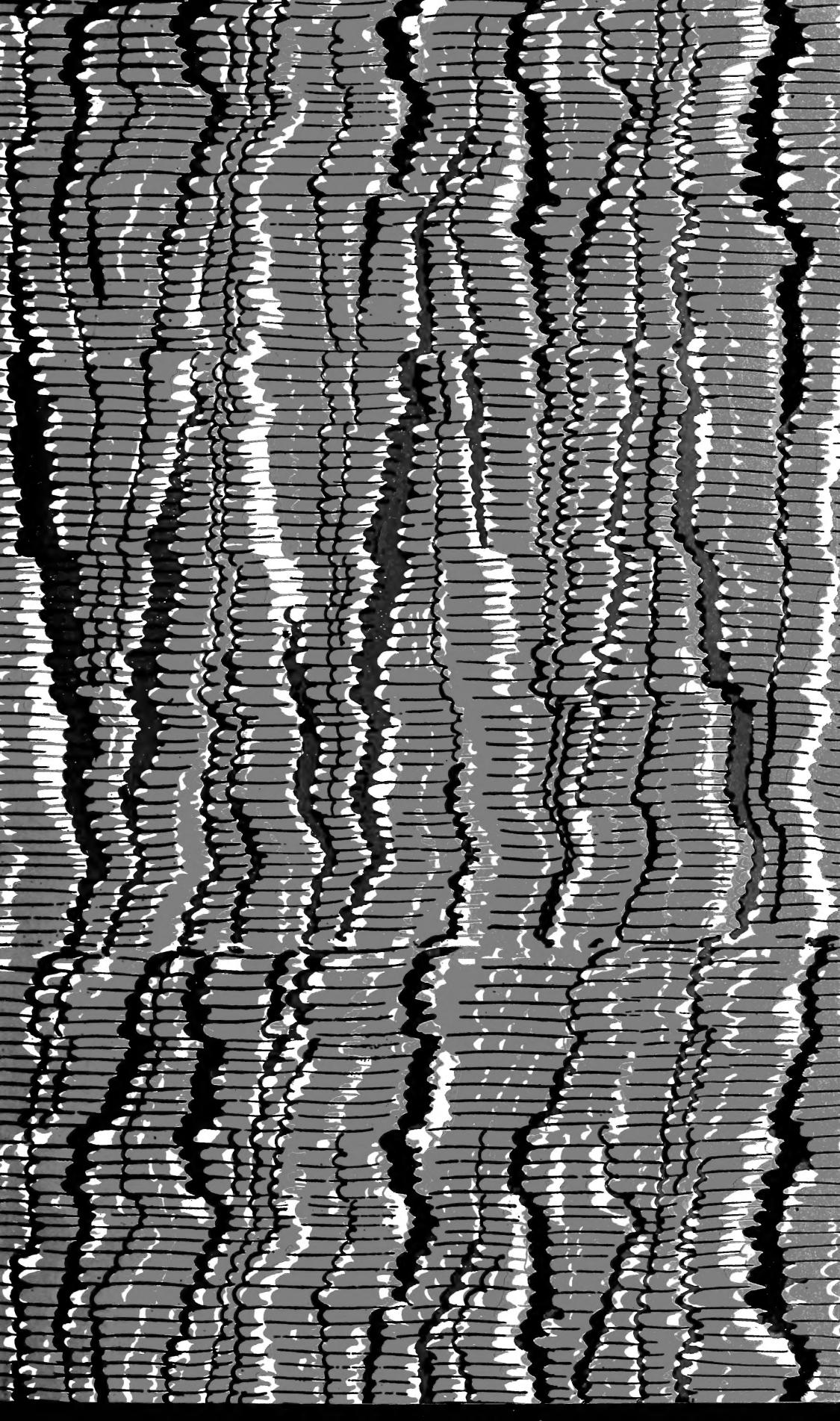
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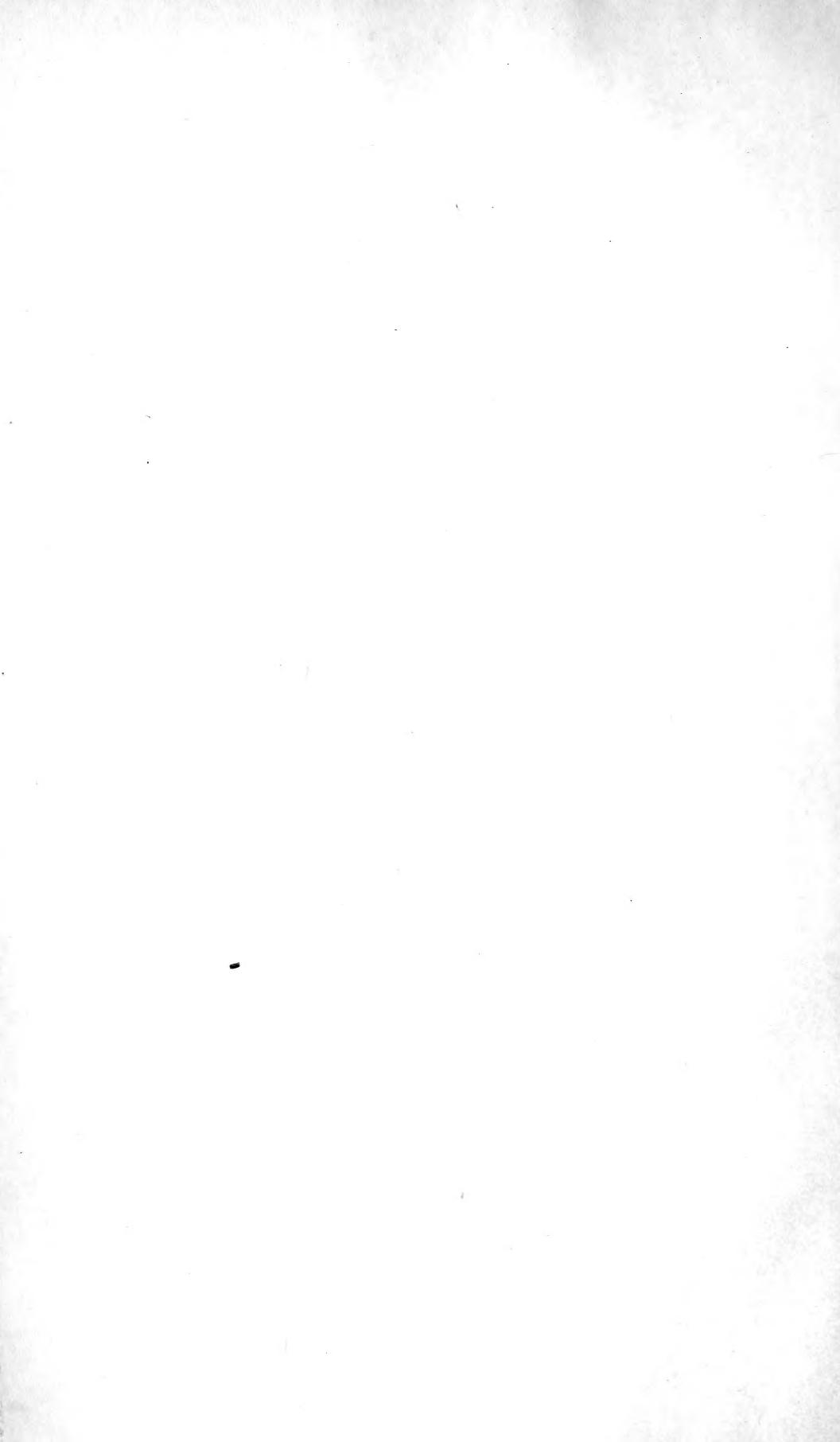


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U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ENTOMOLOGY.

L. O. HOWARD, Entomologist and Chief of Bureau.

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THE STRUCTURE OF CERTAIN DIPTEROUS LARVÆ WITH PARTICULAR REFERENCE TO THOSE IN HUMAN FOODS.

BY
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Washington, D. C.

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF ENTOMOLOGY,
Washington, D. C., September 1, 1911.

SIR: At frequent intervals and for many years the Bureau of Entomology has been appealed to by medical men and others to determine insects said to have been passed by sick people. The majority of these insects have been maggots (larvæ of Diptera). The characteristics distinguishing these larvæ have not been well understood, and the accompanying manuscript is the result of a competent effort by Mr. Banks to assist workers in the study of internal myiasis. I recommend that it be published as No. 22 of the Technical Series of this bureau.

Respectfully,

L. O. HOWARD,
Entomologist and Chief of Bureau.

Hon. JAMES WILSON,
Secretary of Agriculture.

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THE STRUCTURE OF CERTAIN DIPTEROUS LARVÆ WITH PARTICULAR REFERENCE TO THOSE IN HUMAN FOODS.

INTRODUCTORY.

There is a considerable number of flies whose larvæ either regularly or occasionally live in substances used by man as food. The great majority pass through the intestinal tract without our knowledge, for most of them cause little or no trouble. But sometimes with patients in hospitals or asylums, or in private practice, the physician discovers these maggots, and often suspects them of causing the malady or weakness of his patient.

Many such specimens have been sent to entomologists, but owing to the fact that no one had studied these forms, their characters were little understood, and the identifications have not been of much value. Most of these larvæ belong to a few closely related families of flies that were formerly covered by the name *Muscidæ*. The arrangement of the flies has been the subject of much diverse opinion, while the knowledge of the larvæ is very fragmentary.

For these reasons Dr. Howard, Chief of the Bureau of Entomology, suggested that the writer make a study of larvæ belonging to these groups in the collections of the Bureau of Entomology and the National Museum, so that in the future a more correct determination might be made of the larvæ that are quite frequently sent to this bureau.

OCCURRENCE.

When we consider that these dipterous larvæ occur in decaying fruits and vegetables and on fresh and cooked meats; that the blowfly, for example, will deposit on meats in a pantry; that other maggots occur in cheese, oleomargarine, etc., and that pies and puddings in restaurants are accessible and suitable to them, it can readily be seen that a great number of these maggots must be swallowed by persons each year, and mostly without any serious consequences.¹ Besides

¹ "Taking everything into consideration, we doubt whether, out of ten thousand cases, where the larvæ of two-winged flies have existed in considerable numbers in the human intestines, more than one single case has been recorded in print for the edification of the world by competent entomological authority." Walsh, Amer. Ent., vol. 2, p. 141, 1870.

these there are the fruit-flies, whose larvæ live in apples, cherries, gooseberries, and oranges, and the pomace-flies that hover around grapes, pears, and other fruits.

There are also other Diptera which do not occur in the intestinal canal, but which may deposit eggs in wounds, or in the nose or ears. The screw-worm is a notable insect of this class, and each year one or more cases reach the bureau of this species affecting the nose or ears. The larva of the ox warble or bot-fly (*Hypoderma lineata* Villers) also sometimes occurs in man. The eggs of this species are deposited upon the hairs of cattle and licked off by the animal, develop in the stomach, and the larvæ bore upward to the back, there to cause the "warble." If some of these eggs drop into the milk pail there is a chance that they will be swallowed by a person. So there are various cases recorded, mostly of children, where, in the winter time, a larva is observed under the skin, usually in the neck or shoulders, and upon removal proves to be the larva of the bot-fly in its second stage.

Many of the muscid and sarcophagid larvæ deposit eggs or larvæ upon dead animals. Although these animals are usually too far along in decomposition to serve as food, yet in some cases these eggs are deposited in time to be taken when the flesh is eaten. In most cases, however, such flesh is cooked enough to kill the contained maggots.

The larvæ of the Muscidæ often occur in manure as well as on decaying vegetable and animal matter. Prof. Portchinski, of Russia, has studied a number of Russian species of these coprophagous and necrophagous Diptera, and his several papers are the most valuable heretofore produced upon them. Unfortunately for us these papers are published in the Russian language. The late Baron von Osten Sacken gave a summary of one of them in English; and of another, most valuable from the systematic point, the writer has been able to secure a translation of several portions. In this paper¹ he gives descriptions of the larvæ, as well as their habits, and tells how to distinguish the allied forms. He has used several of the characters which will be used in this paper, especially the posterior stigmata and the anal tubercle. He has not touched on the fruit-flies, however, nor has he given any generalizations for the separation of the larvæ of the various families.

Several other naturalists have studied individual species of the Muscidæ or Sarcophagidæ, and in some cases published extremely valuable papers upon them. Thus Lowne has worked up the blowfly, Hewitt the house fly, Blanchard the screw-worm, Portchinski the *Sarcophila wohlfahrti*, and Newstead the stable fly. In the Annales

¹ Biologie des mouches coprophages et necrophages. <Hor. Soc. Ent. Ross., vol. 26, pp. 63-131. 1891.

de la Société Entomologique de France there are good figures by Laboulbène of *Teichomyza* and some other species.

Interest in the larvæ and the life history of these species of flies arises also from their medical and sanitary importance. The famous tsetse flies (*Glossina* spp.) of Africa are related to the stable fly. One of these flies distributes the Nagana disease of cattle, while another species disseminates the sleeping sickness of man. The Congo floor-maggot is also related; this species inhabits the huts of the natives, and at night crawls from the cracks to attack and suck blood from sleeping persons. The Bengalia fly is also related; it deposits eggs or larvæ on the skin of man and dogs in Africa. But the house fly is by far the most injurious species, since its habits are such that the germs taken up by its proboscis from sputum and dejecta are scattered over food about to be eaten by man.

There are also various species of these flies injurious to domestic animals; notably the horn fly, which is a serious pest to cattle. The stable fly annoys cattle, and the sheep maggot (*Lucilia sericata*) injures both the sheep and the wool. The screw-worm, or heel fly, is a serious pest of cattle, and also attacks man.

The occurrence of dipterous larvæ in man is known as "myiasis." Various divisions are given; as "myiasis externa" or "myiasis dermatosa," for those in the skin or wounds; "myiasis intestinalis," for those in the alimentary canal; "myiasis narium," for larvæ in the nose; etc. The occurrence of larvæ in the nose in this country is rather accidental, and usually due to the screw-worm. In tropical countries such cases are much commoner, and in the East Indies a disease known as "Peenash" is due to larvæ in the nose.

A great number of papers has been published on the medical side of myiasis, often with some description of the maggot, but it is not necessary to list them here.

These maggots, as previously stated, usually do not cause any trouble, but Alessandrini has shown in a study of the cheese skipper that these larvæ may cause intestinal lesions in a dog. The vitality of these larvæ is such that they are not readily affected by the digestive fluids, and in fact are resistant to many chemical substances that one would suppose fatal to them. It is therefore perfectly possible for these larvæ to continue their development in the intestine, especially in cases of constipation.

No other group of insects affects human health and human interests more seriously or directly than the flies of the *Muscidæ* and *Sarcophagidæ*. It is therefore of the greatest importance that the larvæ of these flies should be studied in order that it may be possible to distinguish them with accuracy.

LIFE HISTORY.

The life history of these flies presents many remarkable and peculiar phenomena. The females of a number of them deposit eggs which hatch, and the larva pursues the normal line of development. With other species the larva hatches within the body of the parent and is deposited in the first stage or sometimes in the second or even third stage. In *Mesembrina* the larva is deposited in the second stage, in *Dasyphora* in the third stage. Upon what food the larva develops within the body of the parent is not yet known; Portchinski thought that they might feed on undeveloped eggs which he observed near the larvæ. It seems difficult, however, to believe this possible. In the allied tsetse flies the larva, when deposited, is fully grown. The various stages of larval development at deposition serve to lessen the differences between the Pupipara and other Diptera.

In the number of eggs deposited these flies vary greatly, some species, like *Musca corvina*, *Myospila meditabunda*, and *Mesembrina mystacea*, deposit only 24 eggs or less; these, however, are quite large. *Pyrellia* and *Graphomyia* lay about 50 eggs; *Musca domestica* and *Cynomyia* deposit between 100 and 200 smaller eggs, while *Calliphora erythrocephala* lays from 400 to 600 eggs, all extremely small.

Similarly those larvæ deposited alive vary in number and size. *Hylemyia strigosa* deposits but one or two large larvæ in the first stage, while *Sarcophaga hæmatodes* deposits 40 to 60 smaller larvæ.

After deposition there is sometimes a variance in development. In *Musca domestica* there are the usual three larval stages; the first with a heart-shaped aperture to the posterior spiracles, the second with two slits, and the third with three winding slits. In the allied *Myospila meditabunda*, according to Portchinski, the eggs are much larger and fewer in number than in the house fly, the larva upon hatching has the usual simple heart-shaped aperture to the posterior spiracles, but from this first stage the larva transforms directly to the third stage with three slits in each stigmal plate, thus omitting the second stage. This enables the fly to pass through all stages quickly, and to breed during hot weather and in small patches of manure that are apt to dry up too quickly for use by some other flies.

Portchinski has shown that the coprophagous habit induces viviparity. *Mesembrina meridiana* is coprophagous and viviparous; the other species, *Mesembrina resplendens*, lays eggs and is not coprophagous. The coprophagous *Dasyphora pratorum* is viviparous, while *D. lasiophthalma* lays eggs; *Hylemyia strigosa* is coprophagous and viviparous, while most other species of the genus deposit eggs.

Portchinski also claims that the same species may vary in these habits; according to him *Musca corvina* in northern Russia lays

about 24 rather large eggs, while in southern Russia this fly deposits a large larva in the first stage, which passes into the third stage omitting the second stage. It may be that he has made a wrong identification, but he claims to have been particularly careful in this matter.

With the fruit-flies the eggs are deposited on or in the immature fruit, the larvæ feeding on the pulpy substance till full grown, and then crawling from the fallen fruit into the soil for pupation.

CLASSIFICATION.

The dipterous larvæ that may be swallowed by man belong to several families included in the old group of Muscidæ. These families are the true Muscidæ, Sarcophagidæ, Anthomyiidæ, and Trypetidæ. Other groups, as Drosophilidæ, Sepsidæ, and Ortalidæ, are of much rarer occurrence. The flies of the Ortalidæ, Trypetidæ, and Sepsidæ are quite different from those of the other groups, but the adults of the three other families are very similar in structure, and the limits of the groups or the number of groups is not constant with different specialists in Diptera. Some would separate a group known as the Calliphorinæ from the Muscidæ; others make a special family for the biting Muscidæ (Stomoxyidæ). It is not the writer's purpose to make any choice of the different plans, nor does he consider that families should be defined by larval characters, but after the descriptions of the several species a few words will indicate what sort of a classification would result from a study of these larvæ. The groups used in the tabulation of the larvæ are used only for the larvæ and do not indicate any opinions about the arrangement of the flies.

There are other flies whose larvæ are sometimes reported as swallowed by persons, particularly the rat-tailed larvæ of *Eristalis*, which sometimes get into drinking water.

GENERAL CHARACTERS.

(See fig. 1.)

The larvæ of all these forms are broadest near the tip of the body, and taper forward, more so in the true Muscidæ than in the other groups. The surface of the body may be smooth or scabrous, provided with minute, acute granules or teeth, or with short, stiff hairs. With many forms there is on the anterior border of most of the segments a swollen ring or girdle; sometimes only on the ventral side. In some cases there are other swollen areas, or pads, usually fusiform in shape.

The first segment; or head, commonly appears bilobed when viewed from above, and each lobe bears a minute, cylindrical tubercle or papilla (fig. 1, *a*). Below is the mouth aperture; at one side and

above it is the pair of mandibles or great hooks (fig. 1, *b*), sometimes fused into one. At the base and to one side of the mouth orifice is a striated semicircular flap or lobe, called the stomal disk. These are more or less distinct according to the amount of distension and varying with the species. Below the mouth is a short transverse piece, the labium. Behind the head segment there is another segment which is only clearly seen when the head is greatly protruded; this hidden segment is known as "Newport's segment," and the writer has not counted it in treating of the number of segments, since it was not considered by Portchinski and others in describing these larvæ. The second (apparent) segment bears on each side, in the full-grown larvæ, a short fan-shaped process, the anterior spiracle (fig. 1, *c*); each spiracle shows at its tip a number of lobes, varying, with the species, from four or five to forty or more. Some of the segments show fusiform areas on the venter and on the sides; those on the venter are called ventral fusiform areas (fig. 1, *d*) and those on the sides, lateral fusiform areas (fig. 1, *e*). The last segment of the body has a large area (fig. 1, *h*) on the end containing two chitinized subcircular plates, the posterior stigmata. These, in the adult, have

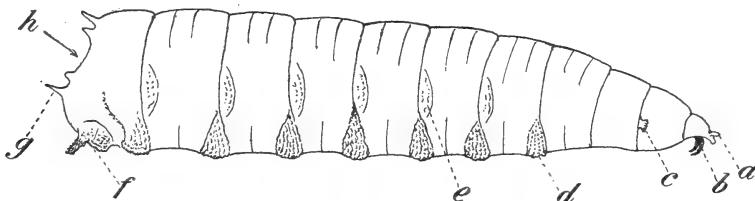


FIG. 1.—Larva of a muscid: *a*, Papilla of head; *b*, great hooks; *c*, anterior spiracles; *d*, ventral fusiform area; *e*, lateral fusiform area; *f*, anal tubercle; *g*, apical spines; *h*, stigmal field (containing posterior stigmal plates). Enlarged. (Original.)

each three slits or sinuous apertures and sometimes a rounded mark, or button, at their base. In some forms the area or field around the stigmal plates is sunken, forming a deep cavity, with the plates at the bottom. The margin or lips of the cavity often bear conical processes (fig. 1, *g*), normally 12 in number. At the lower base of the last segment is the anal field. Each side of the anus is a smooth, convex area or lobe, whose size depends upon the extent of protrusion, and above is a transverse swollen area, often spinulate, and sometimes with a cone at each corner (fig. 1, *f*).

Within the head or, rather, anterior part of the body is a chitinous framework, consisting of several articulated parts, called the cephalopharyngeal skeleton. The outer part is the hypostomal sclerite, to which are articulated the mandibles or great hooks; behind the hypostomals is a pair of large sclerites, nearly divided to their base; one branch is very thin and broader and longer than the other, which is more chitinized, and rounded at tip; they have been called the

lateral plates. From their base, near the origin of the hypostomals, there projects forward and upward a pair of slender pieces, the parastomal sclerites. The shape and proportion of these parts vary with the different species and are quite different in the newly-hatched larva than in the full-grown maggot.

The anterior spiracles do not appear on the larva while in its first stage, but usually appear in the second stage, although sometimes deferred till the third or full-grown stage.

The posterior stigmal plates in the larvæ of the first stage are quite small and generally have a simple heart-shaped aperture; in the second stage, the plates become more elongate and each has two short slits. In the third stage, there are always three slits of varying shapes according to the species.

The number of segments in the body of a larva is a disputed question. Apparently there are 12; with the hidden Newport's segment, this would make 13, a number accepted by several investigators. Others, however, claim there are really 14 or 15 segments.

SYNOPSIS OF THE GROUPS.

1. Body with lateral and dorsal spinose processes.....	<i>Homalomyia.</i>
Body without such processes.....	2
2. Body ending in two fleshy processes; rather small species.....	3
Body truncate or broadly rounded at end.....	4
3. Processes bearing the stigmal plates; body about 5 mm. long.....	<i>Drosophila</i>
Processes not bearing the stigmal plates; body 10 mm. in length or longer.....	<i>Piophila.</i>
4. But one great hook; posterior stigmal plates with winding slits; no distinct lateral fusiform areas; tip of body with few if any conical processes.....	<i>Muscinæ.</i>
With two great hooks; slits in the stigmal plate not sinuous.....	5
5. No tubercles above anal area; no distinct processes around stigmal field.....	6
Distinct tubercles above anal area; often processes around stigmal field; lateral fusiform areas usually distinct.....	7
6. Stigmal plates on black tubercles; lateral fusiform areas distinct.....	<i>Ortalidæ.</i>
Stigmal plates barely if at all elevated; lateral fusiform areas indistinct; stigmal plates often contiguous or nearly so; slits long and subparallel.....	<i>Trypetidæ.</i>
7. Slits in stigmal plates rather short, and arranged radiately.....	8
Slits slender, and subparallel to each other.....	9
8. Two tubercles above anal area; stigmal field with distinct processes around it.....	<i>Anthomyiidæ.</i>
Four or more tubercles above anal area; slits of stigmal plates usually pointed at one end.....	<i>Muscina.</i>
9. A button to each stigmal plate; slits rather transverse to body.....	<i>Calliphorinæ.</i>
No button to stigmal plates, slits of one plate subparallel to those in opposite plate; plates at bottom of a pit.....	<i>Sarcophagidæ.</i>

SARCOPHAGIDÆ.

In the Sarcophagidæ the hooks are two in number and the posterior stigmal plates have three straight slits as in the Calliphorinæ. However, these slits are not directed toward those of the opposite plate

but are subparallel to them. Moreover, the stigmal field is strongly depressed to form a deep stigmal pit, at the bottom of which are situated the stigmal plates. The segments of the body bear complete rings of spinose areas, and often supplementary pads on the sides.

Sarcophaga larvæ prefer animal matter, and have been found in cheese, oleomargarine, pickled herring, dead insects, and human feces.

Sarcophaga incerta Walk.

(Plate IV, fig. 75.)

Body mostly scabrous, each little wrinkle or stria giving rise to a very short, appressed, stout, spinelike bristle. Head deeply bilobed, each lobe tipped with a very short papilla; mandibles two, well separated. About seven lobes in the anterior spiracle. The basal two-thirds of segments 3 and 4 is scabrous; beginning with segment 5 there is a scabrous fusiform pad each side, and the ventral area of the scabrous basal ring is much broadened and transversely divided by a furrow. Behind this is another longer transverse furrow rather behind the middle of the segment. The dorsum of these segments shows four transverse areas, the posterior one rather broader than the others. The last segment is short, scabrous; the anal area not very prominent, scabrous, and with a small conical tubercle at each outer corner. Stigmal pit about one and one-half times as long as broad, its upper lip with three large, scabrous tubercles each side, the intermediate one rather smaller than the others, the lower lip with two large tubercles, and a median pair of smaller ones slightly back from the margin. Stigmal plates about one-half their diameter apart, each with three slits, subparallel to those in the opposite plate; no button.

Sarcophagid A.

(Plate IV, figs. 73, 74, 78.)

Body broad and rather flattened. Head small, bilobed, and a minute antenna on each lobe; two well-separated mandibles. Apex of second segment roughened; the anterior spiracles hemispherical, and occupying a depression at base of the second segment, provided with a number of small tubercles; third segment at base with swollen ring, showing striæ and punctures; surface of the following segments minutely, transversely striate and punctate. Each segment transversely divided, both above and below, into three regions, as shown in the figures; all more or less swollen, and a swollen area on each side; last segment striate and punctate as other segment; anal area hardly prominent, with a rounded spinulose tubercle at each upper corner; stigmal pit one and one-half times broader than long, rather deep, its lips each with three minute cones or tubercles each side; the stigmal

plates hardly their diameter apart, each with three straight slits, rather divergent from those of the opposite plate.

From *Sarracenia flava* from Florida.

Sarcophagid *B.*

(Plate IV, figs. 72, 76, 79, 80.)

Body moderately stout. Head small, seen from above truncate and slightly emarginate in middle; two approximate mandibles. Anterior spiracles of about 12 lobes; anterior margin of segment 3 and following with a spinulose, elevated ring, widest on the ventral part; also on the posterior margin of segment 4, and following segments, on each side of venter, a short fusiform, elevated, spinulose area pressing against the basal ring of the next segment; much of the general surface of segments also minutely spinulate, but on the venter are some transverse, slightly elevated smooth spots; on segments 3 and 4 are two each side, on segment 5 and following is a transverse elongate area, each side of which bears three more elevated spots, two at the median end, approximate, the other at the lateral end; outside of this is still another, less distinct, smooth, elevated spot; on the median line before these is another elevated area, transversely striate. On the pleuron of each segment, about where one might expect spiracles, there is a smooth, rounded, elevated spot, faintly double on some of the posterior segments. On the dorsum of segments 3, 4, 5, and 6 there is a transverse, anterior row of small, smooth tubercles. From the fifth the following segments, from above, appear divided transversely into three subequal rings, all spinulose. At tip the anal area is prominent, spinulose, and bears at each outer corner an outwardly directed spinulose cone. The stigmal pit is elliptical, one and two-thirds times as long as broad, its upper lip with three subequal, spinulose cones each side; its lower lip with two similar cones each side, and a median pair smaller, and situated more toward the anal area. The stigmal plates, as usual, have three elongate, simple slits; those of one plate subparallel to those of the other.

These larvæ were taken from Limburger cheese on two occasions, and an extremely similar form was received as having been passed in feces.

Sarcophaga sarraceniæ? (so labelled).

Body pitted over almost the entire surface, and from each pit arises a tiny stiff bristle; sometimes the surface is minutely wrinkled, and near the tip more spinulose. The anterior spiracles show about 12 lobes. The posterior ventral half of segments 3 and 4 is smooth, but the posterior ventral area of the others is crossed by a broad band of these pits and bristles. Around each segment is the usual basal ring, and on the posterior sides is the usual fusiform area

pressing against the ring of the following segment, all with pits and bristles. On the pleuron of each segment, about where one might expect spiracles, is a minute tubercle, on the penultimate segment rather large. Above, the segments from 5 on are transversely divided into four parts; the second part from in front is narrower than the others. At the tip the anal area is prominent, with the two outwardly projecting spinulose cones rather larger than in the *Sarcophaga* from Limburger cheese; the upper lip of the stigmal pit has three spinulose cones each side, the outer one the largest, the intermediate one the smallest; the lower lip shows two cones each side as large as the inner of the upper lip, and a median pair smaller and situated back from edge of lip; the stigmal plates have the usual six simple subparallel slits. The penultimate segment shows above a subapical transverse row of small tubercles.

Sarcophagid C.

(Plate IV, figs. 70, 77.)

Head rather deeply emarginate from above. Anterior spiracles with about twelve lobes. Each segment has the usual basal elevated, spinulose ring, which is very prominent; from the fifth segment on there is on each side the usual apical fusiform, swollen, spinulose area pressing against the ring of the next segment; the rest of the surface of the segments, both above and below, is smooth, or faintly striate; on the venter of each segment are two small indistinct, smooth tubercles each side. The anal area is prominent, spinulose, and with the usual two outer spinulose cones; beneath there is a smooth, blackish area, crossed by a furrow, perhaps ordinarily covered by the anal tubercle. The stigmal pit is about once and a half longer than broad; its upper lip with three very small cones each side, the intermediate so very minute as to be almost absent; the lower lip has two small cones each side, and a median pair below, and away from the margin.

Reared from decaying vegetables.

Sarcophagid D. (From grasshopper, *Melanoplus*.)

(Plate IV, figs. 64-66.)

Body rather stout; second segment seen from above broad, smooth; anterior spiracles short, of about eight lobes. Other segments with a basal, swollen ring, which is covered, but not very closely, with short, acute spinules, stouter than those in some of the other species. Beginning with segment 5 there is the usual fusiform area pressed against the ring of the next segment, also with the stout spinules; the general surface of all the segments (except 2)

is also provided with these spinules, but not so abundantly. Around the middle of each segment, from 4 on, there is a row of about 22 tubercles, mostly smooth; on each side of the ventral line are three of these on a slightly swollen area, like that seen in the *Sarcophaga* from Limburger cheese. On most of the ventral segments is a transverse area in front and one behind the row of tubercles which does not have the spinules, but is transversely striated. On the dorsum the segments from 5 on appear to be divided into three transverse portions, the middle one bearing the row of smooth tubercles. Anal tubercles not very prominent, with a short, stout cone at each corner, all spinulose. The stigmal pit is small, nearly egg-shaped, about one and one-fourth times as long as broad; its upper lip with the usual three cones each side, all short, the intermediate one very small; the lower lip has also the usual two cones each side, small, and a median pair still smaller, and remote from edge of lip. The stigmal plates and slits are as usual in the genus.

Chrysomyia macellaria Fab.

(Plate IV, figs. 67, 68, 69, 71.)

The head from above is distinctly bilobed; there are two distinct mandibles; the anterior spiracles are very short, and contain only 7 lobes. The posterior upper part of segment 1 is swollen and spinulose. Each of the following segments (except 2) has a basal, swollen ring, armed with reclinate teeth, the teeth of the anterior row always the larger. Beginning with segment 6 the ventral part of each ring is much broadened and divided transversely by a narrow smooth space. On segments 5 to 10 there is each side behind a fusiform swollen area pressing against the swollen ring of the next segment; this area is also spinulose. The tip of the body shows on the dorsal part a great cavity, in the bottom of which are the stigmal plates, each with three straight slits, those of one subparallel to those of the other; no button. Behind the cavity is a high, transverse, spinulose crest; and the ventral part of tip shows a spinulose area bearing two rather widely separated, prominent, smooth tubercles. The dorsal edge of the tip shows four small conical tubercles.

The "screw-worm", as the larva of this insect is called, occurs in sores and wounds of domestic animals, and also in man. There are various records of its presence in the ears and nose, or nasal cavities, of people, from swelling near the nose, from a boil under the arm, under the skin of a child, and in the navel of a child. It is therefore hardly a possible factor in internal myiasis, and most of such recorded cases probably belonged to some species of *Sarcophaga* whose larvæ are very similar in appearance to those of the screw-worm.

Chrysomyia (?)

(Plate III, figs. 39, 47, 52.)

Head showing a lobe each side, each tipped by a distinct antenna; mandibles two, well separated; base of second segment a swollen ring, finely obliquely striated; each of the following segments with a basal swollen ring, and furnished with spinules; beginning with the fifth segment there is an apical, fusiform, spinulose area each side, pressing against the ring of the next segment; elsewhere the surface is smooth and shining, each segment with two faint grooves around its middle; anterior spiracle with about 10 lobes. The last segment shows below at base a transverse spinulose area; the anal area is not very prominent, spinulose, and with a prominent conical tubercle at each outer corner; the posterior stigmal area occupies the dorso-caudal surface, but hardly forms a pit, with six small tubercles on each lip, those on upper lip rather larger; the stigmal plates are rather close together, have no button, and each shows three straight slits, subparallel to those in the other plates.

Various specimens taken from fish, at the Barbados, West Indies.

CALLIPHORINÆ.

In the Calliphorinæ there are two hooks or mandibles, and the posterior stigmal plates have each three straight slits directed more or less toward those of the opposite plate. The stigmal field is usually outlined by conical tubercles, but not especially depressed. The anal tubercles are usually spinose, and the prothoracic spiracles rarely, if ever, have more than 15 lobes. The segments usually show a more or less complete ring or spinose area on the segments beyond the fifth. This group is very close to the Sarcophagidæ, and some species of *Lucilia* are nearly as well placed there as here.

Calliphora erythrocephala Meig.

(Plate III, figs. 62, 63.)

Head distinctly bilobed from above, each lobe with a minute papilla; two well-separated mandibles; anterior spiracles with from nine to twelve lobes. Beginning with the third, each segment shows an apical swollen ring or girdle, whose surface is seaceous; these rings are broader below than above, and are here emarginate on the posterior middle. Each ventral segment, beginning with the fifth, is divided by a transverse groove near the middle. The anal area shows a smooth median process, divided in middle, and at each outer corner is a cone. The stigmal field is rather concave, the upper lip with three small tubercles each side, the lower lip with two larger tubercles each side, and a median pair smaller and lower down; the stigmal

plates are about once and a fourth their diameter apart, each with three simple, straight slits, directed slightly downward, but mostly toward those of the opposite plate; the button is distinct.

The blow-fly deposits eggs on dead animals, and also on fresh and cooked meat. As such meats are often accessible to them in pantries, it is readily seen that many larvæ are swallowed by people each year; we have, however, comparatively few records, probably because the food causes no trouble.

Protocalliphora chrysorrhœa Meig.

(Plate III, figs. 56-58.)

Body rather short, thicker than usual behind. Head plainly bilobed from above, each lobe bearing a distinct papilla, two separate bifid mandibles; posterior margin of first segment with a broad reflexed margin, bearing a fringe of black hair. Surface of body closely, minutely scabrous; beginning with the third segment there is below a median, transverse, apical, elevated, smooth lobe; on segments 4 and 5 there is a lateral lobe at each side; each segment from below also shows a transverse, median furrow, and above most of the segments show a broad, transverse depression. The anal area is smooth, and shows an oblique lobe at each side; a median depression, partly covered by a median lobe from above. Stigmal plates small, about two to three diameters apart; each with three straight slits directed obliquely downward and slightly toward those of the other plate.

Pawnee on Delaware, Pa., attached to young bluebirds in nest, July; Wellesley Hills, Mass., on nestling bluebirds, June. It also occurs in Europe, and is there known to feed on young birds.

Lucilia sericata Meig.

(Plate III, figs. 54, 55, 60, 61.)

Body rather stout, not slender in front. Head very distinctly bilobed, with distinct antennæ; mandibles two, well-separated. Anterior spiracle with about eight lobes. Surface of body mostly smooth; pleura of segments 3, 4, and 5 bilobed; beginning with segment 6 there is a basal ring or girdle, roughened; these girdles on segments 6 to 9 are widened on middle of venter; these pleura are also swollen, but not plainly bilobed, except those near tip. The ventral segments are transversely divided by a line or furrow in the middle. Last segments short, stigmal field occupying most of the tip, slightly depressed, upper lip with three sharp tubercles each side, the intermediate one hardly smaller than the others; lower lip with two large, sharp tubercles each side, and a median pair more remote from the margin. Anal area rather sunken, with a small rounded

tubercle at each outer corner. Stigmal plates about one-half their diameter apart, each with three straight slits, directed somewhat toward each other, but also downward.

This species has been recorded in Holland and other parts of Europe as very injurious to sheep. The larvæ, feeding in matted parts of the wool, start sores on the skin, which they invade and feed on the matter, producing ugly, ulcerated patches.

Mr. W. W. Froggatt has recorded a species of *Calliphora (oceanica)* as causing similar sores on sheep in New South Wales.

Meinert has reared another *Lucilia (L. nobilis)* from larvæ taken from the ears of a sailor.

Lucilia sylvarum Meig.

(Plate III, figs. 48-51.)

In general similar to *L. sericata*. A bilobed head, two mandibles, about eight lobes to the anterior spiracle, surface of body mostly smooth. A roughened ring around each segment; beginning with the sixth segment this ring is broadened below, and traversed by a narrow smooth space; the dorsal part of these rings for the last few segments is very weak and obscure. The last segment is rather short, with the stigmal field hardly concave; the upper lip with three small, subequal tubercles each side, smaller than in *L. sericata*, lower lip with two tubercles each side, and a median pair, removed from edge of lip. Anal area rather prominent, roughened, with two small, rounded, approximate, smooth tubercles below, and one pointed and roughened at each outer corner. Stigmal plates about one-half their diameter apart, each with three straight slits, pointing somewhat toward each other, but not so much as in *Calliphora*; an approach to the condition of *Chrysomyia*.

Myospila and *Auchmeromyia*.

Portchinski has figured *Myospila*, showing that it goes in the Calliphorinæ, and Newstead has figured the Congo floor-maggot, *Auchmeromyia luteola* Walk., which also belongs here.

Gedoelst has figured larvæ of *Cordylobia*, which is considered to be a calliphorine, but these larvæ appear to be much nearer to the Estridæ.

MUSCINÆ.

According to the larval characters the Muscinæ form a very sharply restricted group. There is but one great hook, and the posterior stigmal plates have three sinuous slits; characters not found (as far as known) in any of the allied forms. The anterior part of the body is more slender than in *Calliphora* and *Sarcophaga*. The spinose parts of the segments are confined to the ventral surface; the anal

tubercles are smooth, and there are no prominent tubercles outlining the stigmal field. The prothoracic spiracles have only a few lobes.

Musca domestica L.

(Plate I, figs. 1-4, 16.)

The larva of the house fly has been described by several authors, and very fully by Dr. Hewitt. The body is slender and tapering in front; large and truncate behind. The head has a tiny papilla each side and there is but one great hook, apparently the union of the pair seen in other forms. The prothoracic spiracles show six or seven lobes; on the ventral base of the sixth and following segments there is a transverse, fusiform, swollen area provided with minute teeth. The anal area is but slightly prominent and shows two approximate processes. The stigmal area is barely if at all concave and not outlined by tubercles; the spiracles are prominent, less than their diameter apart, each with three sinuous slits, and a button at the base. In some cases two of the winding slits are apparently connected. The second stage has but two straight slits in each stigmal plate, while in the first larval stage there are two smaller slits on a tubercle each side of the middle, and in this stage there are no prothoracic spiracles.

The larva of the house fly is rarely swallowed, but there are records to that effect, and it sometimes breeds in decaying fruits and vegetables.

Pseudopyrellia cornicina Fab.

(Plate I, figs. 11-15.)

Body rather slender in front, broad and truncate behind. Head from above distinctly bilobed, each with a distinct papilla; one large mandible or hook. Anterior spiracle six or seven lobed. Surface generally smooth at junction of segments; there are on sides usually a few short, longitudinal tubercles or striæ. Beginning with the sixth segment each has on the ventral base a transverse, swollen, fusiform area or pad which is provided with two rows of tubercles or longitudinal teeth. Each ventral segment also shows a transverse groove before the middle. The penultimate segment has a fusiform area at apex below with tubercles upon it. The last segment has the anal area not very protuberant, above is a slender median process, and at each side a larger, slender, lateral process; from them a row of small teeth extends upward and toward base. The posterior stigmal plates are large, close together, and each has the three winding slits characteristic of the true Muscidæ.

The specimens were taken from cow dung, which harbored larvæ of *Lyperosia irritans* L.

Muscid *B.*

(Plate III, figs. 40-43.)

This larva is plainly larger than that of the house fly, and less tapering in front; the head is blunt and rounded, and the papillæ are not distinct; there is but one mandible; the anterior spiracles are six-lobed. The fifth segment has below on base a slightly swollen area which is transversely striate; the sixth and following segments have on the ventral base the usual fusiform area, but little swollen, faintly divided on the median line, and with many longitudinal teeth or short ridges; the dorsum is smooth. The anal area is sunken, but the upper margin shows a median lobe with three smaller lobes each side; surface of last segment smooth; stigmal plates small, deep black, about their diameter apart and each with three sinuous slits, similar to those of *Musca*.

Several specimens sent from New York that were passed by an epileptic patient in December and January. This species is closely related to the house fly, but to what genus it belongs is yet uncertain—perhaps to *Graphomyia*.

Lyperosia irritans L.

(Plate I, figs. 5-7.)

The body of the horn fly larva is very slender, especially in front. Head bilobed, each lobe with a tiny papilla; one mandible, not very large. The anterior spiracles have six lobes. The general surface of the body is smooth or very minutely striate; the fourth ventral segment at base shows an area with tubercles or small teeth; beginning with the sixth, each segment has on the ventral base the transverse, fusiform, swollen area, with two rows of longitudinal teeth or tubercles, and also each ventral segment shows a transverse groove before the middle, and the penultimate segment has at base beneath a spinulose fusiform area. The last segment is rather evenly rounded above, the stigmal plates close together, and each with three winding slits, as in allied forms. The anal area is moderately protuberant, mostly black, and shows below a smooth submedian lobe each side, and laterad of this a larger smooth lobe; above is a pair of more prominent, smooth, black tubercles; each side of these is a smaller cone and above is a transverse row of teeth.

Specimens came from cow manure containing also the larvæ of *Pseudopyrellia cornicina*.

Stomoxys calcitrans L.

(Plate I, figs. 8-10.)

The larva has been described and figured by Newstead and later by Hewitt. It is similar in shape to that of the house fly, with a single great hook or mandible; the anterior spiracles have five lobes; the

sixth and following segments have each a ventral basal fusiform area provided with tubercles; the anal area has two submedian tubercles and three lobes each side of these; above them is a row of minute granules, ending each side in a larger granulate tubercle; there are no tubercles outlining the stigmal area; the stigmal plates are subtriangular, about one and one-half times their diameter apart, black, and each with three pale areas containing a sinuous or S-shaped slit, but these slits are not near each other at the end as in *Musca*, and there is no apparent button.

It commonly breeds in manure of various kinds, but also in decaying matter, and is not often passed by people, but there is one record. It is recorded that in parts of Africa *Stomoxys* attacks dogs so viciously that the ears are often seen raw and bleeding from their bites.

Mesembrina and *Dasyphora*.

Portchinski has described and figured the larvæ of *Mesembrina* and *Dasyphora*.¹ His figures show the posterior spiracles with the winding slits as in *Musca*, and in *Mesembrina* he figures the single great hook, so that these genera also belong in the Muscinæ as here restricted. Both genera have the posterior spiracular plates semi-circular, but in *Mesembrina* they are very faintly trilobed; in both genera the plates are very close together.

Glossina.

The tsetse fly normally deposits a full grown larva, although specimens in captivity have sometimes deposited partly grown larvæ. This larva is short, subcylindrical, of a yellowish-white color, and at the truncate posterior end are two large, rounded, black processes, which have finely granulated surfaces. At the ventral base of each of the segments 4 to 10 is a narrow, transverse, fusiform ridge. Austen, in his account (Brit. Med. Journ., 1904, pt. 2, p. 659) says that "in the larger larvæ the tips of the mouth hooks can be seen, slightly protruding from the cephalic end." It would therefore appear that they had two separate mouth-hooks, and not one as in *Stomoxys* and *Musca*. If this be the case *Glossina* is not closely related to *Stomoxys*.

MUSCINA GROUP.

The larvæ of the Muscina group are in general related to the true Muscidæ, but differ at once in the simple, short, pointed slits in the posterior stigmal plates. The great hooks lie close together so that they approach the azygos condition seen in *Musca*. Most of the classifications keep *Muscina* in the true Muscidæ, but from the larval standpoint it must be separated.

¹ Hor. Ent. Soc. Ross., vol. 26, pp. 91, 118, 1891.

These forms infest overripe fruit, and since such fruit is apt to cause sickness, these larvæ are frequently reported by physicians.

Muscina stabulans Fall.

(Plate II, figs. 17, 18, 19, 27, 28, 36.)

Head bilobed from above, no distinct antennæ; two closely approximate mandibles; anterior spiracles of about six lobes. Surface of segments mostly smooth; beginning with fifth segment there is on the venter a long, basal, transverse, fusiform swollen area, furnished on the crest with rows of teeth; each of these areas is divided on the median line. On the penultimate segment there is a similar area at tip, but not divided; the segments below also show a transverse line before the middle. The last segment has the anal basal area spinulose, but not very prominent, and with a median and three lateral spinulose tubercles in a nearly transverse row; the rounded tip of the segment shows, across the middle, faint traces of four low cones. The stigmal plates are scarcely elevated, black, less than their diameter apart, and each with three very short slits pointing toward those of the opposite plate.

The larva of this species is common in decaying vegetable matter; and it has been reared from rotten apples, pears, squash, mushrooms, and dead insect larvæ. In one case a considerable number was passed by a child suffering from summer complaint.

Laboulbène records larvæ of this species vomited by a person suffering from bronchitis.

Muscina assimilis Fall.

(Plate II, figs. 20-22.)

Head bilobed, each lobe with a prominent papilla; mandibles two, well-separated. Anterior spiracles with about nine lobes. Surface smooth; the rings or girdles to segments distinctly outlined, but little swollen; they are faintly scabrous, and on the ventral surface broadened and transversely divided by a furrow; there is also on most of the ventral segments a short, median, transverse line; the anal area appears extruded as a broad, rather flattened lobe, traversed by median and transverse grooves; the tubercle above has a small cone at each outer corner. The stigmal field is margined on each upper side by three very small conical tubercles, and behind by a transverse row of four large conical tubercles close together, and laterad of them is a minute tubercle. The stigmal plates are rather more than their diameter apart, and each shows three short, straight slits directed toward those of the opposite plate; the button is distinct.

Larvæ in roots of a melon vine.

Near *Muscina*.

(Plate II, figs. 23-26.)

Body slender, especially so in the anterior part; segments 3, 4, and 5 with a ridge around near tip, and faintly spinulate. Beginning with the fifth segment the ventral area is swollen, and with two bands of spinules. At the ventral base of the last segment there is a row of seven rounded tubercles, all nearly smooth, the median smaller than the others; the middle one of each side is at the end of a curved swollen area which extends under the submedian tubercle. The tip of body is truncate, and with four tubercles on the upper edge and four below; those above are rather prominent, but those below are small, and the outer ones scarcely visible. The stigmal plates are elevated, and each has three straight slits, directed toward those of the opposite plate; the button is distinct. The anterior spiracles have six long lobes. The head, seen from above, shows a truncate lobe each side.

This has been sent in two cases as passed in feces, both localities in the South.

Muscid A.

(Plate II, figs. 33, 37, 38.)

Head from above bilobed; two closely approximate mandibles; anterior spiracles short, with four lobes. Segments generally smooth; beginning with the fifth each has a transverse line on middle of venter; beginning with the sixth each has a basal, transverse, fusiform, spinulose area on the venter; on the penultimate segment there is one at tip, and on last segment one at base surrounding the anal area, which is not prominent, but shows two smooth brown areas on the middle, and each side a small tubercle. The fourth segment shows above and on sides a raised line near the posterior edge, also a finer line on basal part of last segment; the segments at their juncture are usually contracted. The last segment is rather flat on top, but evenly rounded below, and without tubercles; the stigmal plates elevated, scarcely one-half their diameter apart, each with a button and three short straight slits pointing toward those of the opposite plate.

Sent in from the South as passed in feces.

Muscid C.

(Plate II, figs. 29-32.)

The bilobed head has a papilla each side; two separate great hooks; the anterior spiracles are semicircular and with many (about 20) lobes; segment 5 and those beyond have each a swollen, fusiform area on the ventral base, each with transverse ridges; lateral fusi-

form areas not prominent, a transverse line on ventral middle of most segments; the anal area shows four hispid tubercles in a transverse row; stigmal plates black, a little elevated, each with three short pointed slits, and a button; a pair of cones above and a pair of smaller cones below stigmal plates.

In orange from Mexico, with *Trypeta ludens*, No. 4242.

Muscid *D.*

(Plate II, figs. 34, 35.)

Body long and slender, the bilobed head with small papilla; two great hooks; anterior spiracles with about six lobes; a narrow, fusiform, swollen area on the ventral base of the segments beyond 4, each with transverse ridges; a transverse line on ventral middle of these segments; lateral fusiform areas distinct; tip of body large and truncate, no distinct tubercles but two low humps above and less distinct ones below the stigmal plates; latter small, about their diameter apart, each with three rather short, subparallel slits, and directed toward those of opposite plate, the button distinct. Anal area with three smooth, rounded tubercles each side, and a less distinct median one, each tubercle with a few fine grooves on tip; a transverse granulated ridge in front of the anal tubercles.

From Alaska, probably taken on cabbage.

HOMALOMYIA GROUP.

The larva of Homalomyia has long been known because of its peculiar appearance, and the frequency with which it is associated with human food. These larvæ are flat and fusiform, each segment provided with long bristly processes. The mouth parts are obscure, and the stigmal plates occupy a dorsal position on the last segment of the body.

So very different are these larvæ from the ordinary anthomyiid larvæ that they should stand in a group by themselves.

Homalomyia sp.

(Plate VI, fig. 106.)

The larva of the genus Homalomyia is entirely different in general appearance from any of the other forms considered in this paper. The body is flattened, and bears above a pair of long spinous processes on each segment, forming two submedian rows; there is a row of similar processes on each upper and lower side, making six rows of these processes on the body; on the head is a pair of anteriorly-directed processes, and the last segment, whose posterior surface is apparently turned upward, has two of these processes on each side,

and a pair of longer ones on the hind margin. These processes, and the general surface of the body, are usually scabrous. Near the upper base of the last segment is a small trilobed process each side; these are the posterior spiracles, and each has three short, straight slits. Each ventral segment is transversely divided by a narrow furrow or line which terminates each side in a slight tubercle. The last segment has behind the usual transverse line another much curved, and with a double median forward extension.

There is a number of species of *Homalomyia*, differing in the proportions of the processes, and Walsh described three species from the larval stage. There are many records of the passage of *Homalomyia* larvæ, and we have others in the office. Since they feed on fruit and vegetables that are just beginning to decay one can readily see that they are often swallowed by people. They also breed, at least some species, in human feces, and as the flies occur in houses they are, in a lesser way than the house fly, the possible conveyors of disease.

ANTHOMYIIDÆ.

(Plate VI, in part.)

The larvæ of Anthomyiidæ are of the general shape of the larva of the house fly, but hardly so slender in front; the head shows distinctly a pair of papillæ; there are two separate great hooks; the anterior spiracles have not many lobes, often but 6 to 10 (13 are figured for one species); segment 5 and others beyond have each a swollen fusiform area on the ventral base, which is provided with roughened ridges; the lateral fusiform areas are well developed. The caudal end is truncate, but barely if at all sunken, and margined with a number of short, fleshy tubercles, about eight to fourteen in number, according to the species, some rather larger than others, and often with four of them in a transverse row; there are, usually at least, two tubercles above the anal area; the stigmal plates are not far apart, and each has three short slits arranged more radiately than in the other groups; sometimes the button is absent.

A few notes on some of the common species occurring on foods and elsewhere will serve to show the range of form in the family.

In *Pegomya fusciceps* Zett. (figs. 111, 116) there are four simple, conical tubercles in a transverse row below the stigmal plates; the stigmal plates do not show a button; and the anterior spiracles have about six lobes.

In *Pegomya cepetorum* Meade (fig. 119) there are four simple slender tubercles in a row and the stigmal plates are similar to those of *P. fusciceps*, but the anterior spiracles are larger and have about ten lobes.

In *Pegomya brassicæ* Bouché (figs. 107, 113, 114) and *P. planipalpis* Stein the median tubercles of the four in a row are broader than the others and bifid at tip, more deeply so in *P. brassicæ* than in *P. planipalpis*, and the stigmal plates show a distinct button; the anterior spiracles have about 10 lobes. In a *Pegomya* from Alaska, taken from cauliflower, the median tubercles of the four in a row are very broad and trifid at tip.

In *Pegomya ruficeps* Stein the body is shorter and stouter, and with many swollen areas and transverse lines; the anterior spiracles have about 12 lobes; the median tubercles of the four in a row are much smaller than the others; the stigmal plates are slightly elevated, each with the three radiating slits, but no distinct button.

The larva of *Pegomya bicolor* Wied. (figs. 110, 112) has all the tubercles at tip of body small; the four in a row are all equally small; the stigmal plates as shown in figure 112; the anterior spiracles rather large, and with about 12 small lobes; there is a swollen area of ridges all around each segment from the fourth backward. A larva, supposedly an anthomyiid, on roots of roses, shows at tip (fig. 117) four large processes; the stigmal plates being on the inner base of the smaller processes.

Carpenter has figured in *Pegomya betæ* Curtis two prominent teeth on the great hooks; the anterior spiracles with eight lobes, and the stigmal plates far apart.

Hewitt has published a fine account of *Anthomyia radicum* L.; no teeth on the great hooks; anterior spiracles with 13 lobes; stigmal plates near each other, and with three rather long slits; the median tubercles of the four in a row are smaller than others and situated a little nearer the stigmal plates; each is bifid at tip; no button is shown on the stigmal plates.

In *Phorbia floccosa* Macq. (figs. 108, 109) the stigmal field is margined by 12 conical processes, and the anal tubercle is in the form of two similar conical processes; the anterior spiracle has but six lobes.

TRYPETIDÆ.

In the few forms of Trypetidæ examined, those that feed in fruits and soft tissue, there are two mandibles or hooks, the tip of the body is destitute of pointed tubercles, and there is one pair of rounded anal tubercles. The posterior spiracles are similar to those of the Calliphorinæ—three simple slits, those of one plate directed toward those of the other. The prothoracic spiracles have numerous lobes, often over twenty, always more numerous than in the Muscidæ or Sarcophagidæ. There are no complete bands of spinules around the body, only fusiform areas on the ventral segments; the stigmal area is not noticeably depressed.

Ceratitis capitata Wied.

(Plate V, figs. 87, 88, 89, 100.)

Body moderately tapering in front, not particularly slender; two distant mandibles; head from above bilobed; anterior spiracles long, with about 15 lobes. The segments show on the venter the usual transverse, fusiform, spinulose areas, and between them on the middle of each segment are two low ridges, which in the median area are connected as in the figure, one of them being broken in the middle. On the posterior border of each segment where it joins the next is a row of pits, and also less distinct a longitudinal row, or two of them, on the side of each segment; on some segments these are more like a line or groove. Elsewhere on the segments there are a few longitudinal grooves and ridges. At apex of body the stigmal area is slightly elevated, the plates long, and each has three short, straight slits. Above them on the upper edge is a pair of distant, conical tubercles; below the plates is a transverse, elevated crest, and on the lower slope is an elliptical, medial area, spinulose around the edge, and containing the two anal tubercles, elongate, and pear-shaped, but not much elevated.

This is the peach maggot of tropical countries.

Acidia fratria Loew.

(Plate V, figs. 91-93.)

Body very pale; not very slender; two approximate mandibles; head from above rounded at tip; anterior spiracles long, with concave upper edge, and about 24 lobes. No part of body spinulose; the swollen parts of segments not very prominent, and striate or wrinkled, not spinulose. At the tip there are below two smooth, approximate tubercles on the anal area, which is not prominent. At dorsal tip is a large process, apparently bilobed from the side, and also from above, bearing in its middle the flat-topped stigmal eminence; the stigmal plates are fully their diameter apart, each with three short slits directed toward those of opposite plate, no apparent button, and no other tubercles.

This species mines the leaves of the parsnip.

Dacus ferrugineus Fab.

(Plate V, figs. 90, 103, 105.)

Body rather thick, anterior part not slender; two widely separated mandibles; anterior spiracles long and of about 38 lobes. Anterior margins of segments 3, 4, and 5 minutely transversely striated above. The ventral region, beginning with segment 4, shows the scabrous elevated areas. The last segment shows beneath a large

scabrous flattened elevation bearing two approximate smooth tubercles. The tip has a faint conelike process each side below the stigmata; the latter are slightly elevated, each showing three straight slits, wide apart and directed toward those of the opposite plate.

Dacus curcurbitæ Coq.

(Plate V, figs. 101, 102, 104.)

Head bilobed from above, each lobe bearing a distinct antenna; mandibles two, distant; anterior spiracles long, with about 20 lobes. Ventral segments 6 to 12 with swollen spinulose areas. The last segment shows below a transversely elliptical spinulose area, rather depressed, and containing two approximate, flat, rounded tubercles; tip of body rounded, with a low, broad swelling at each lower corner; the stigmal plates are approximate, each with three short slits, pointing toward those of the opposite plate.

From melons in Hawaii; No. 8478.

Rhagoletis suavis Loew.

(Plate V, figs. 94-96.)

Body much the largest near the tip; head small, bilobed, each lobe with minute antenna; two stout, blunt mandibles, and laterad of them is a horny crest; anterior spiracles hemispherical, with about 25 lobes; surface of body smooth; beginning with the fifth segment there is a basal, fusiform, much swollen area on the venter of each segment, each transversely ridged and punctate; on the middle of these segments is a transverse line extending down on the sides; dorsum of segments indistinctly divided into three transverse areas; last segment with the anal area near the tip, not very prominent, but with two prominent, approximate, smooth lobes; above the anal area are two minute depressions; the stigmal field is slightly depressed, the plates close together, each with three narrow, straight slits directed toward those of the opposite plate.

From shuck of a butternut, Plummers Island, Md.

Rhagoletis pomonella Walsh.

(Plate V, figs. 83, 84.)

Body rather stout, tapering but little in front; head broad, papilla very small; two great hooks; anterior spiracles broad, with about 15 lobes; each dorsal segment from the third has a basal area of ridges; each ventral segment from the fifth has a broad, basal, fusiform, swollen area, which is very minutely ridged; a transverse line on middle of each ventral segment, and the apex of each segment with an area of several transverse ridges; the lateral fusiform areas are fairly distinct; the anal tubercle is moderately prominent, and

strongly bilobed; the stigmal plates are fully their diameter apart, each with three straight, parallel slits; between the stigmal plates and the anal tubercle are two pairs of distinct, rounded, fleshy tubercles; the two nearer the anal tubercle are closer to each other than are the other two.

Locally common in northern apples.

Rhagoletis cingulata Loew.

(Plate V, figs. 97, 98.)

Head broad, papilla barely visible, two prominent great hooks; anterior spiracles broad, concave above, with about fourteen lobes. Ventral segments from 5 onward each with a broad, basal, fusiform, swollen area, with many transverse ridges; each ventral segment has also in the middle a transverse line or furrow; the lateral fusiform areas indistinct; on the dorsal base of segments 3, 4, and 5 is an area of transverse ridges, barely distinct on the following segments; anal tubercle small, slightly roughened, divided by a longitudinal line; stigmal plates not their diameter apart, each with three short, barely curved slits; between the stigmal plates and the anal tubercle, at the extreme tip of the body, are two low elevations or swellings each side, each with a minute central tubercle, the four forming a curved line.

Common in cherries.

Epochra canadensis Loew.

(Plate V, figs. 81, 82.)

Body subcylindrical, tapering only a little in front; papilla of head very minute; two well-separated great hooks; anterior spiracles broad, broadly emarginate in the middle, with about eighteen to twenty lobes. Ventral segments from the fifth backward with a very narrow, basal, fusiform area, only slightly protuberant, and finely ridged; each of these segments with a ventral, median, transverse line; no lines or furrows on dorsum; no lateral fusiform areas. Apex of body evenly rounded, smooth, no tubercles; the stigmal plates without a button, each with three short, nearly straight slits; anal tubercle distinct, but small, more yellow than the surrounding surface, slightly convex, and divided by a longitudinal line.

From currants; more common in the North.

Anastrepha ludens Loew.

(Plate V, figs. 85, 86, 99.)

Head small, short, bilobed from above; two distinct mandibles; anterior spiracles long, with twenty or more lobes; on the fifth and the following segments is the usual ventral, basal, fusiform area, with

transverse striæ, the area on fifth segment smaller than the others; the anal area shows two large, smooth, prominent, submedian tubercles; there are no tubercles outlining the stigmal field; the stigmal plates are contiguous, each with three short, straight slits directed toward those of opposite plate; these slits are much shorter and broader than in *Rhagoletis*.

This species, the orange maggot, is sometimes found in Mexican oranges.

ORTALIDÆ.

The larvæ of the ortalid flies are rather more slender than those of *Musca*; the two great hooks are distinct; the anterior spiracles have about ten lobes; the ventral fusiform areas are distinct, but the lateral rather weak; the tip of body ends in two slight processes bearing the posterior stigmal plates, each with three short slits.

Most of the species occur in places where they are not apt to be swallowed by man, but the onion maggot, and a few other forms, may occasionally be taken in food.

Euxesta thomæ Loew.

(Plate III, figs. 53, 59.)

Body smooth, slender; two great hooks; two distinct papillæ on the bilobed head; segments from 5 on each with distinct fusiform, swollen area on ventral base, each area with several transverse ridges; lateral fusiform areas fairly distinct; anal area not swollen, and no tubercles; tip of body rounded and smooth, without tubercles; each stigmal plate on an elevated black base, each plate with three short slits and a button, but indistinct; nine lobes in the anterior spiracles.

In ear of corn from Texas.

A similar ortalid from tomatoes in Florida has but five lobes in the anterior spiracles, and the slits on the posterior spiracles are more nearly on the outer edge.

Tritoxa flexa Wied (?)

(Plate III, figs. 44-46.)

Slender; head truncate, with two small papillæ; two great hooks; anterior spiracles with ten lobes; segment 5 and beyond each with a swollen, fusiform area on ventral base, each area with several ridges in front and behind, leaving a smooth space in the middle; a faint transverse line on middle of ventral segments; lateral fusiform areas visible, but not prominent; anal area with a low swollen lobe each side, no tubercles; a few fine ridges above and below anal area; last segment rounded, smooth, no tubercles; stigmal plates on low ele-

vations, about their diameter apart, each with three radiated slits, and a button, incomplete on inner side.

From onions, in Pennsylvania. It is probably this species or its close ally, *T. incurva* Loew.

SEPSIDÆ.

The larvæ of the Sepsidæ are of the muscid shape; the fusiform areas are not prominent except on the venter; the anal tubercle is rather inconspicuous; the spiracles are situated on projections at the tip of the body, and also in the pupæ. Each spiracle has three straight slits.

They breed mostly in manures, but sometimes in decaying fruit; one species, the cheese skipper, has long been known because of its occurrence on old cheeses.

Piophila casei L.

(Plate VII, figs. 122-124.)

The body is of the usual shape, tapering in front. The head is emarginate from above, each corner projecting in a papilla; there are two well-separated great hooks. The anterior spiracles are rather prominent and divided into about ten lobes. The sixth and following segments have on the ventral base a narrow, transverse, fusiform area in which the ridges are broken into minute teeth. The last segment has at tip two processes, each about three times as long as broad at base, and rather more than their length apart; this last segment also has a prominent outer angle each side near the base. The posterior spiracles are situated on the inner tip of a slight protuberance, and each has three straight slits. Each main tracheal tube is black for a short distance from the tip.

The cheese skipper not only occurs in cheese, but also in hams, especially the fatty parts, and in oleomargarine; there are several records of its occurrence in people, and we have one such case.

Alessandrini has recently made experiments with this species on dogs and finds that it passes through uninjured, while it may cause intestinal lesions in the dog. He also found that the larva was remarkably resistant to many chemical substances, supposedly destructive to life.

DROSOPHILIDÆ.

Drosophila.

(Plate VIII, figs. 133, 135-137.)

Body rather slender in front; head with distinct papillæ, two well-separated great hooks; anterior spiracles obscure, not much extruded, with eight to ten long branches or lobes; each segment of

the body is slightly constricted in the middle, with a basal roughened area encircling each segment; anal tubercle broad, dark colored, bilobed, but not very prominent; around tip of body are several pairs of tubercles; five pairs are described for *D. ampelophila* Loew, four pairs for *D. amœna* Loew; the stigmal plates are on the tips of two approximate cylindrical processes which rest on an elevated part of the tip of the body.

The pupæ are rather barrel-shaped, with a slender projection at each anterior corner of the body, the process varying in size and tubercles with the species; the posterior end of the body is provided with tubercles similar to those of the larvæ, and stigmal plates at the tip of a pair of truncate projections. The pupæ are usually found in the same lot as the larvæ, as evidently but a few days are required for them to develop from the eggs.

Drosophila larvæ and pupæ are quite common in overripe fruit, especially grapes, pears, and apples; they also occur in jellies, jams, vinegar, pickles, etc., and so are frequently swallowed by people.

THE CEPHALOPHARYNGEAL SKELETON.

The structure of the cephalopharyngeal skeleton varies with the species. It is not always feasible to use this structure in identifying material, since it usually necessitates the destruction of the anterior part of the larva, which one does not care to do in unique specimens. Figures have been given of this skeleton as seen in several species; but it can not be used as a diagnostic character for groups until one has examined a larger number of species. In the first larval stage this skeleton is formed of very slender pieces, only narrowly connected, but in the second and third stages the parts broaden, especially the lateral plates.

In the Trypetidæ (figs. 125, 132) the lateral plates are only weakly chitinized, and not black; they are deeply indented from behind, so that the upper and lower limbs are connected only for a short distance. The great hooks have a very prominent spur above at base.

In the Ortalidæ (*Euxesta*, fig. 121) the skeleton is very similar to that of the Trypetidæ.

In the three species of *Sarcophaga* examined the lateral plates are not so deeply indented from behind, and the upper limb shows a slender appendage along its lower edge; the great hooks have a spur above at base (fig. 134).

In the Muscidæ (figs. 115, 120) the lateral plates are still less indented from behind, the lower limb being much larger than the upper limb; the hypostomal sclerites are short and heavy; the great hook (for there is but one) has a rather small spur above at base.

In the Calliphorinæ (figs. 126, 128, 131) the lateral plates are deeply indented from behind, and here it is the upper limb that is

the larger. The hypostomal sclerites have a hump or swelling beneath; the great hooks have hardly any spur above at base. In some of the genera, *Calliphora* and *Protocalliphora*, only part of the upper limb of the lateral plates is strongly chitinized.

In *Homalomyia* (fig. 127) there is an approach to the form of *Musca*, the lateral plates only slightly indented, the lower limb the larger, and a basal spur above on the great hooks. In the upper anterior part of the lateral plates, where they unite, is a number of perforations, some round, some elongate; these are not seen in the other families examined, but appear in *Drosophila* (fig. 133).

BEARING OF LARVÆ ON CLASSIFICATION.

The value of larval characters in classification will always be variously estimated by different entomologists, and the writer is far from claiming that any group should be delimited by larval characters. But in view of the diversity of opinion among dipterists as to the divisions of the old family *Muscidæ*, the bearing of these larval structures may be of interest. Some authors have taken *Stomoxys* and *Glossina* from the *Muscidæ* and put them in a separate family, the *Stomoxydæ*. From the standpoint of the larvæ there is no warrant for this separation, *Stomoxys* being much nearer in structure to *Musca* than is either to the *Calliphorinæ*. Looking at these groups from the structure of the larvæ, one will notice that both the *Muscidæ* and the *Anthomyiidæ* possess two styles of larval structure, and it is very difficult to see why these striking differences in the larvæ should not find some corresponding difference in the flies upon which to found a better classification. The larva of *Homalomyia* differs so greatly from that of *Anthomyia* that one can not but think that this difference should be reflected in the adult. Likewise when one considers the peculiarities of the larvæ of *Musca*, *Stomoxys*, *Lyperosia*, and *Pseudopyrellia*, differing from other muscids by important characters at each end of the body, one can hardly believe that there is not some structure of the flies to distinguish them as a group.

The classifications of the *Muscidæ* by Pandelle and by Girschner agree much better with the larvæ than the classifications seen in the catalogues. These authors have put the *Calliphorinæ* remote from the true *Muscidæ* and near the *Sarcophagidæ*; Pandelle also has a distinct group in the *Anthomyiidæ* for *Homalomyia*, and the true *Muscidæ* are included in his *Anthomyiares*. However, the larvæ of the true *Muscidæ* are so different from *Anthomyia* that one would suppose the flies should have a group at least equal in value to that of the *Anthomyiidæ* or *Tachinidæ*. This would indicate three families, *Muscidæ* in the restricted sense—*Tachinidæ*, to include *Calliphorinæ* and *Sarcophagidæ*; and the *Anthomyiidæ*, to include *Muscina* and *Homalomyia*, the latter to have subfamily rank.

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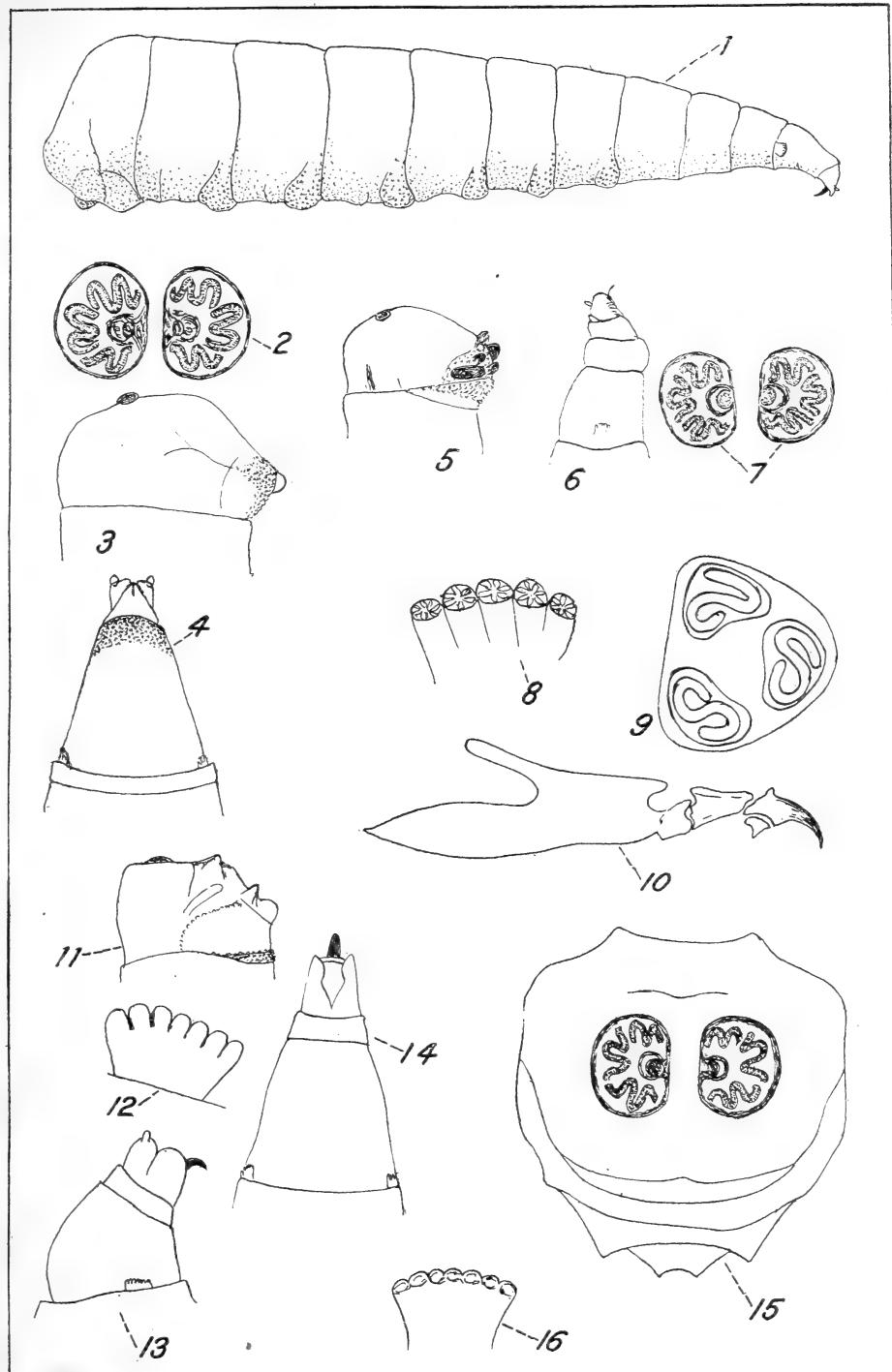
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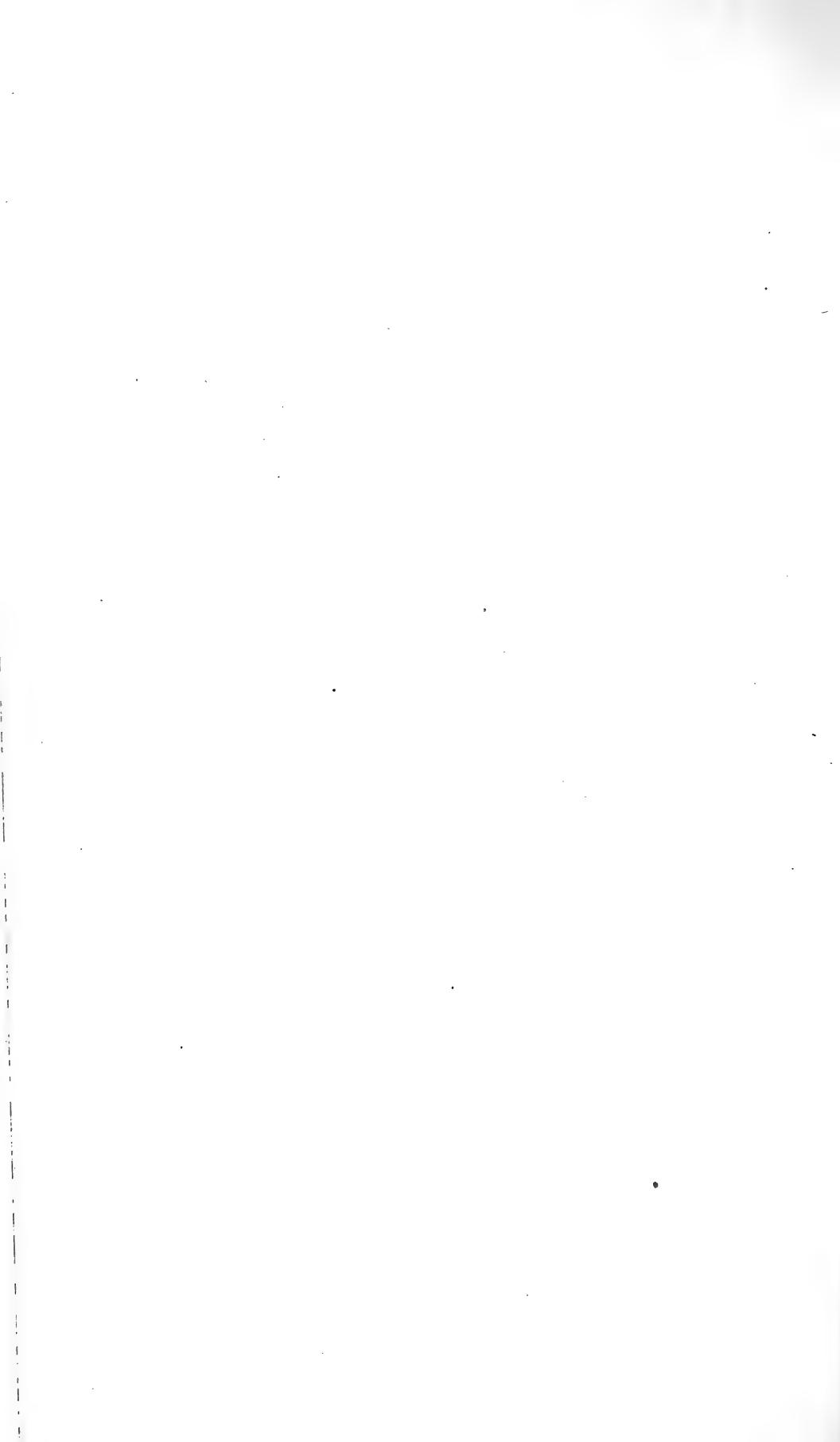
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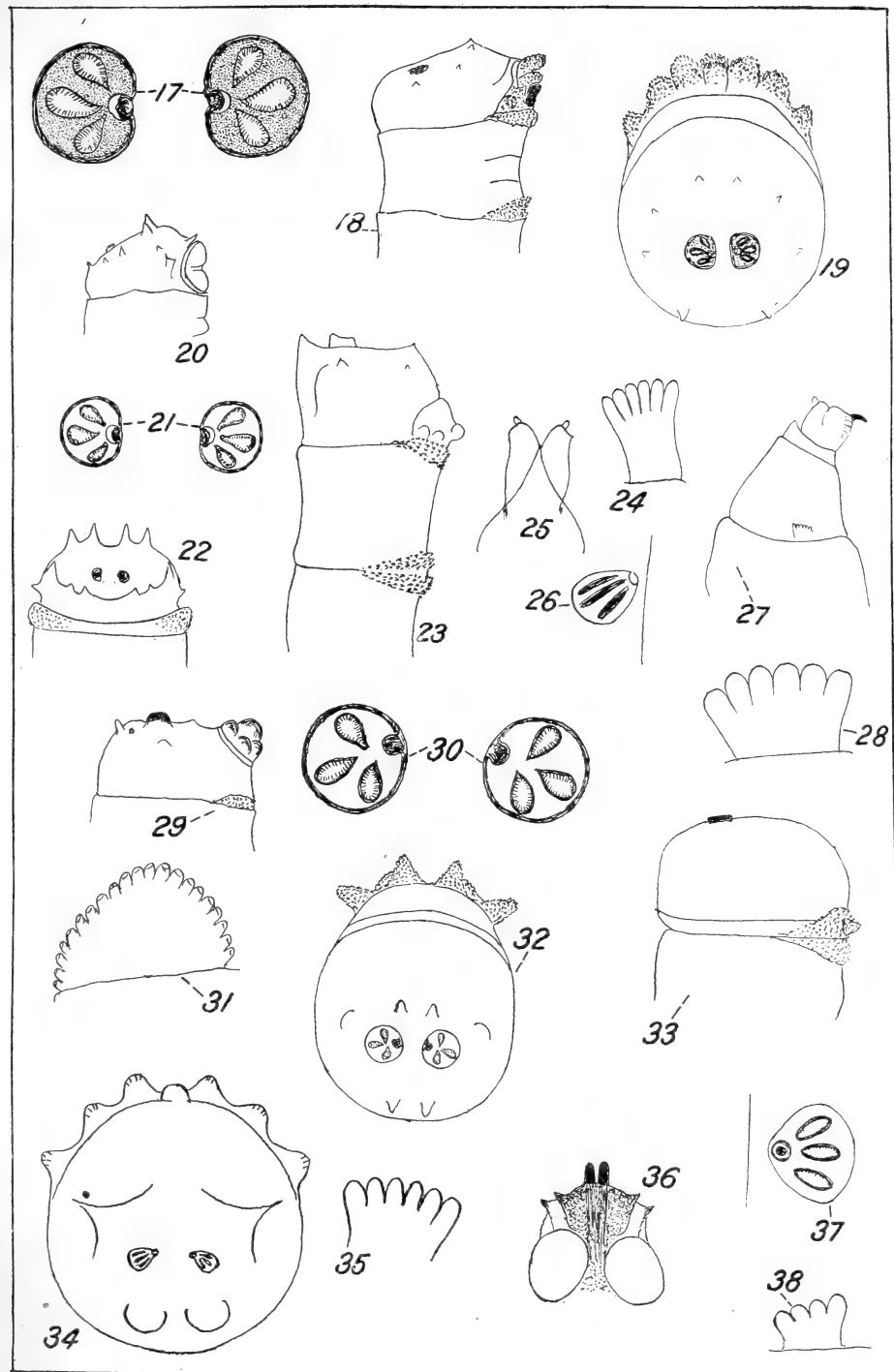
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STRUCTURE OF DIPTEROUS LARVÆ.

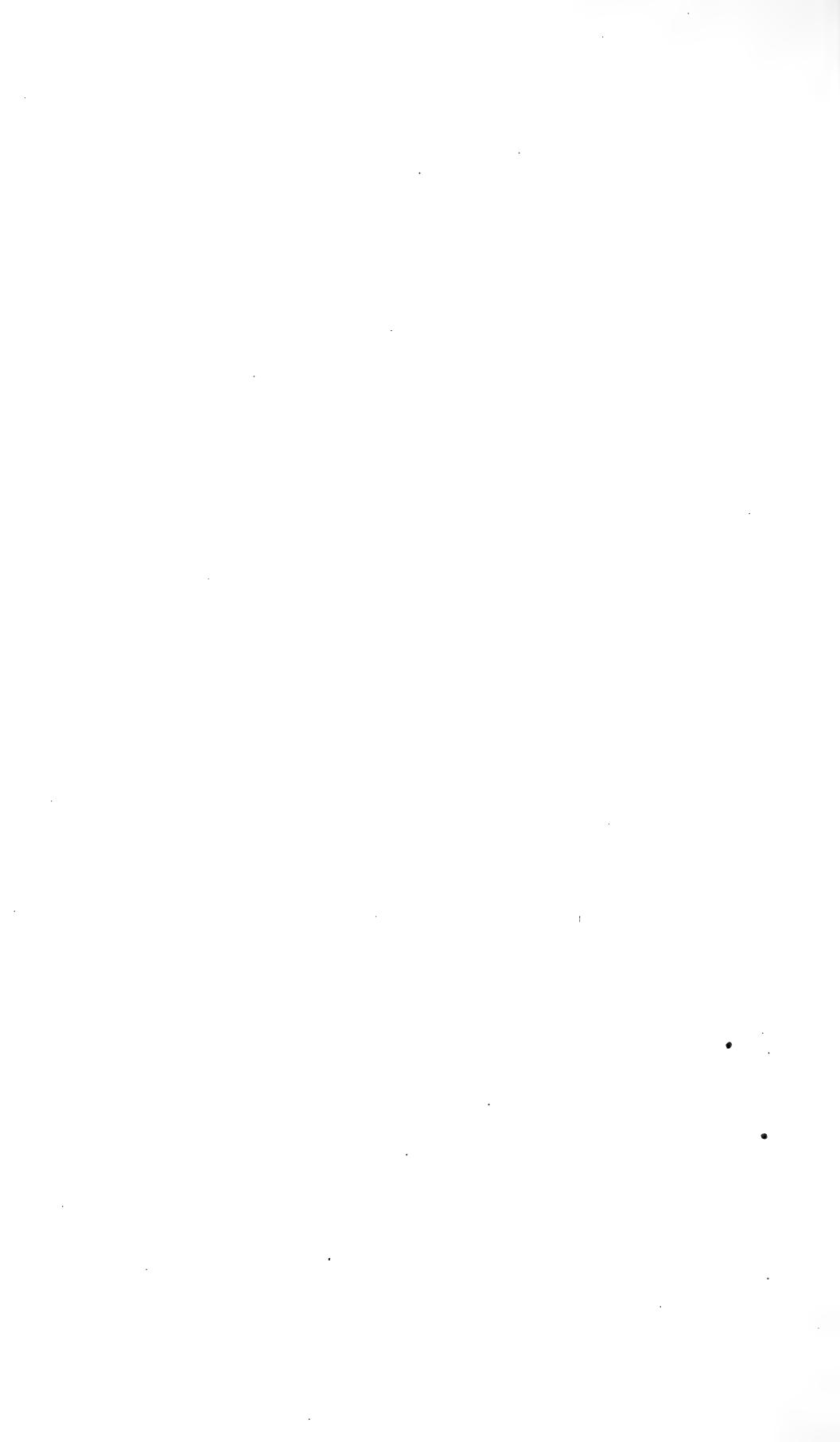
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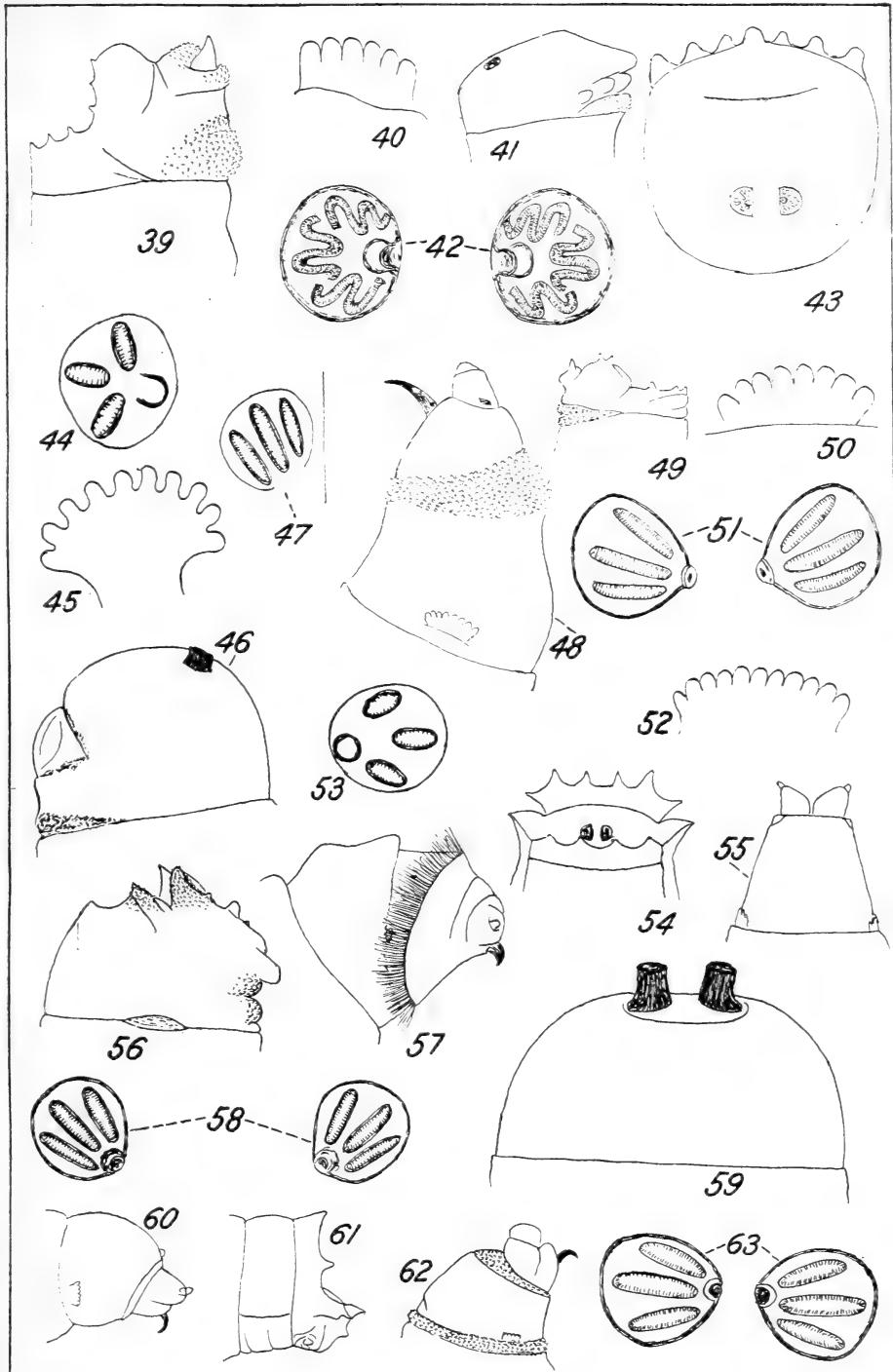




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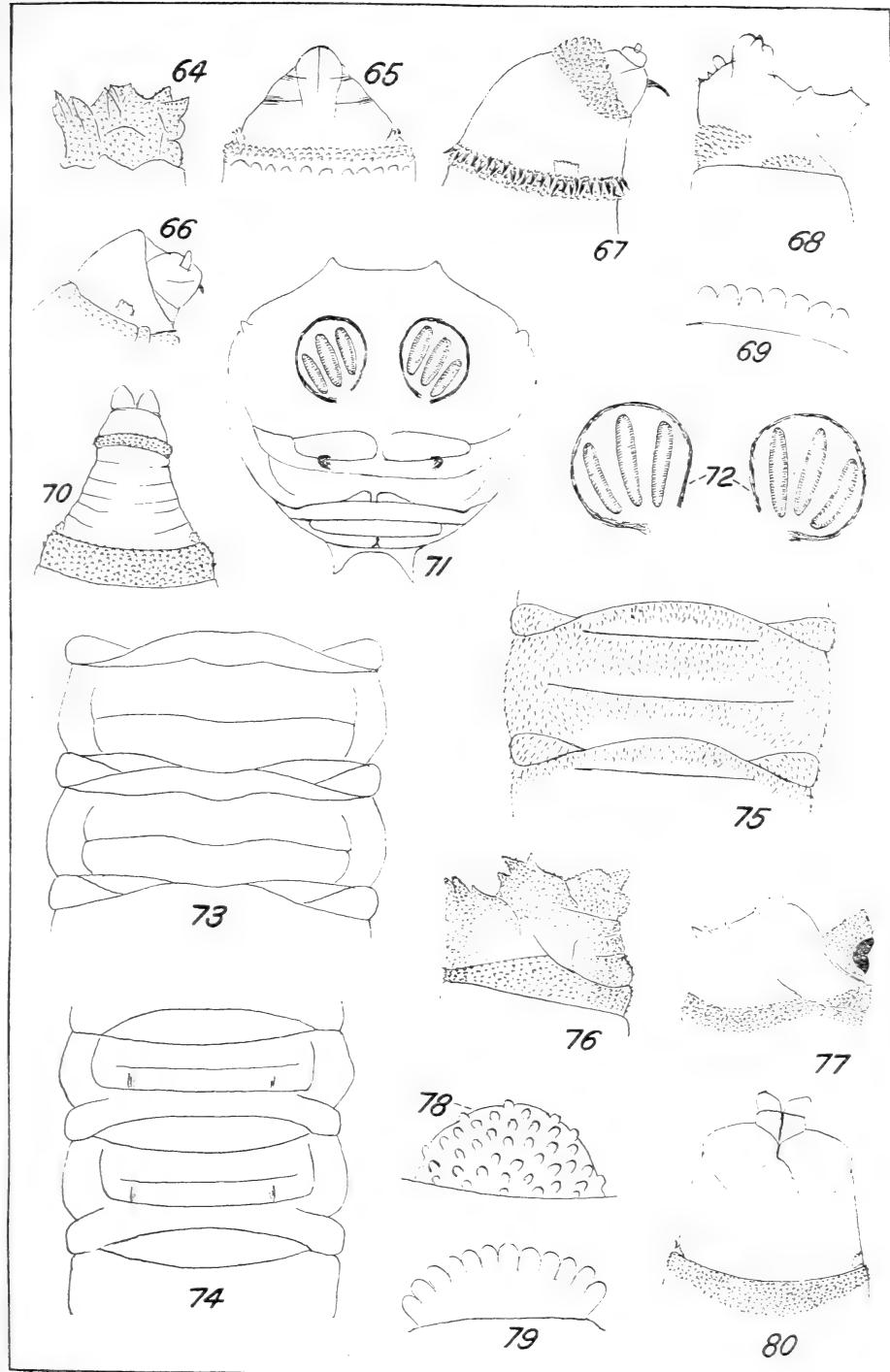
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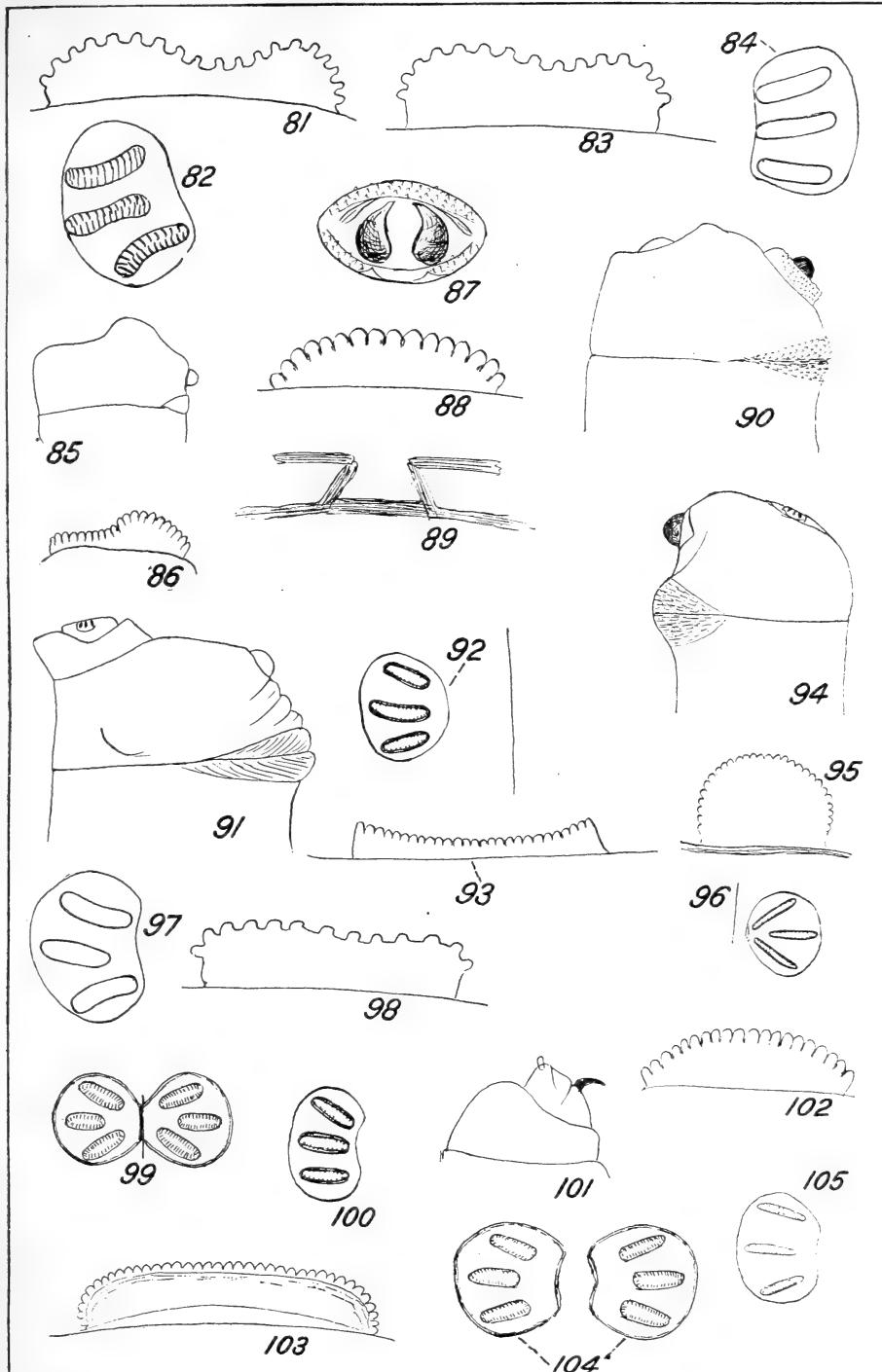
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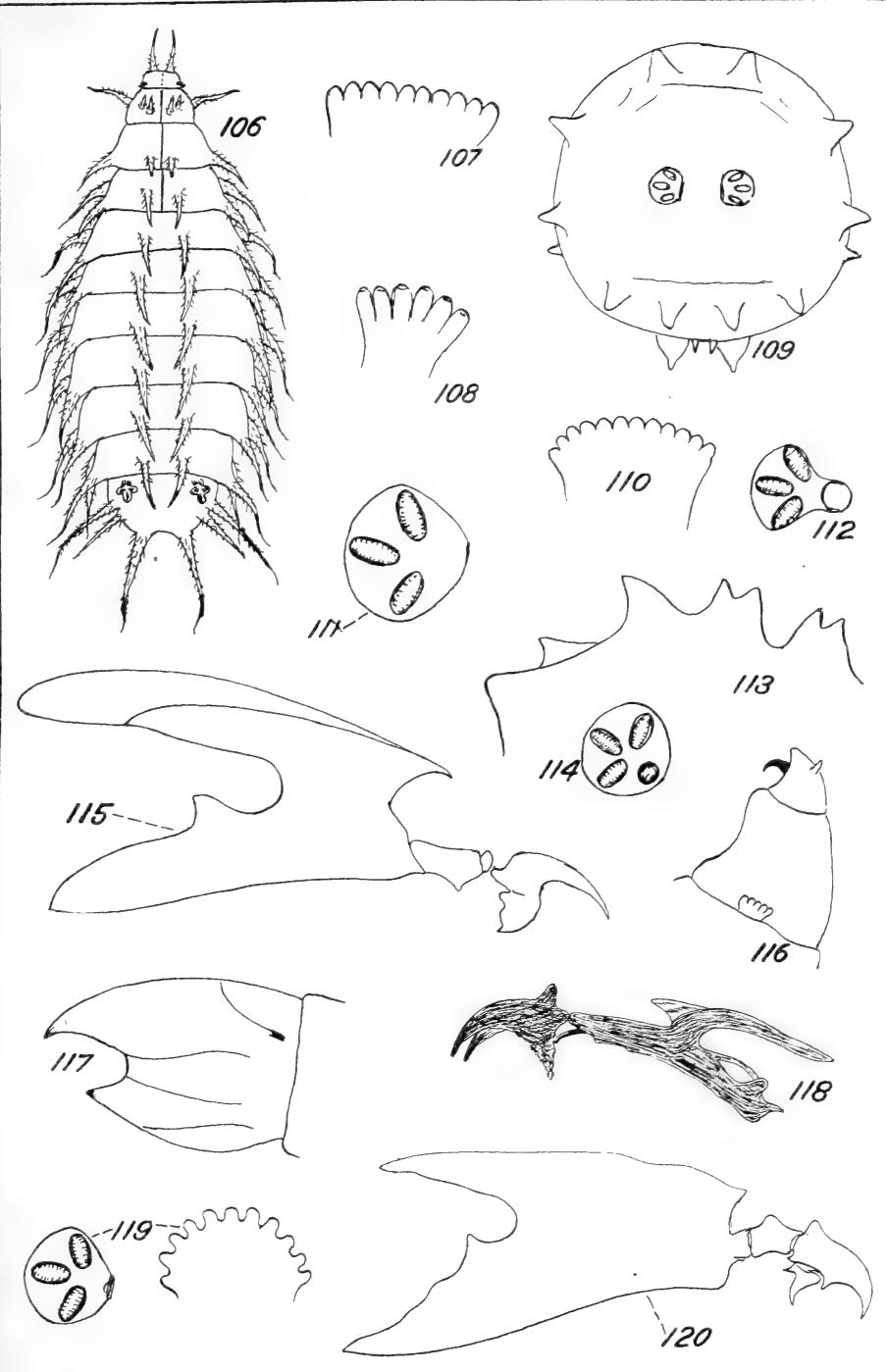
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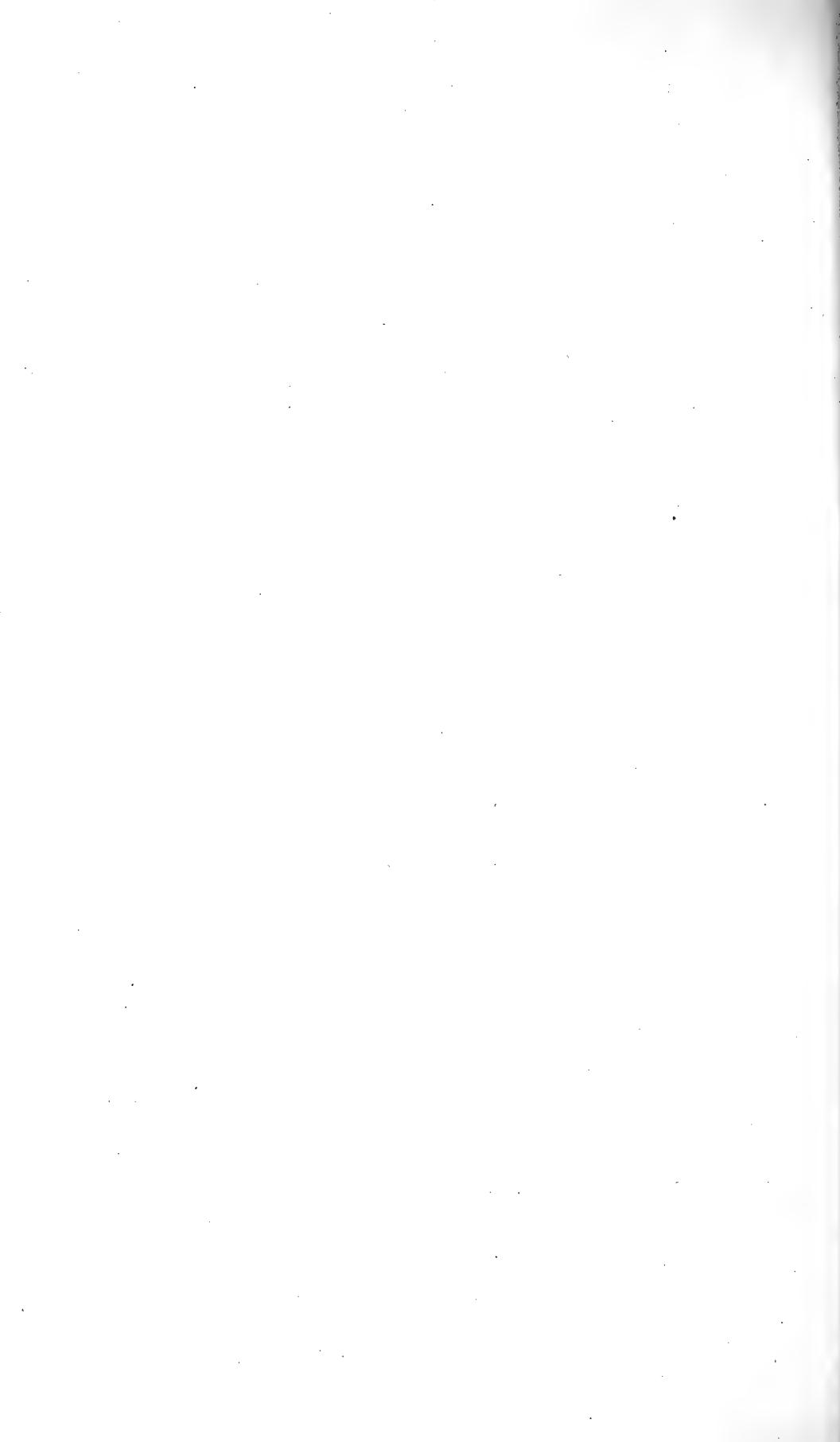
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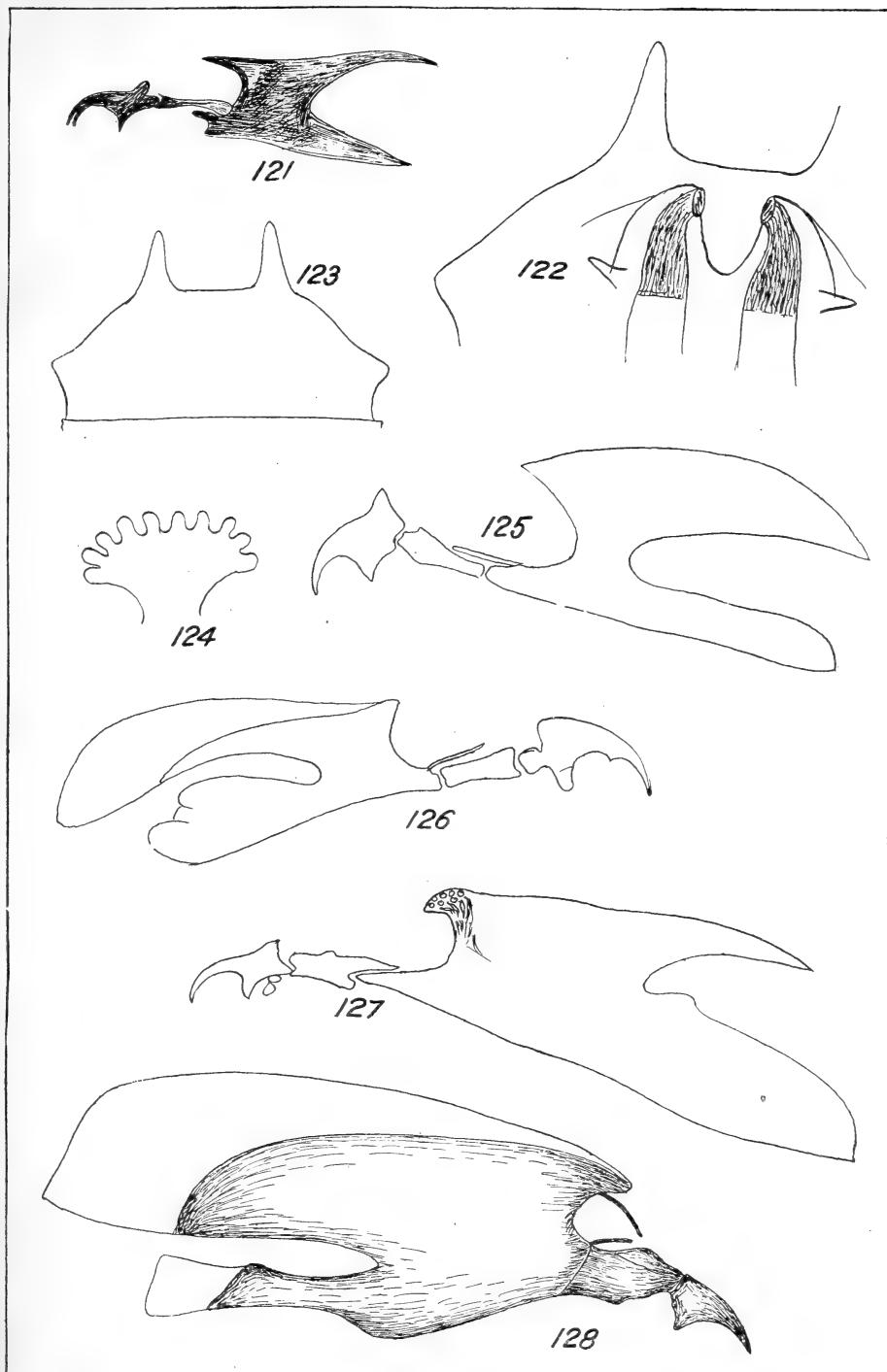
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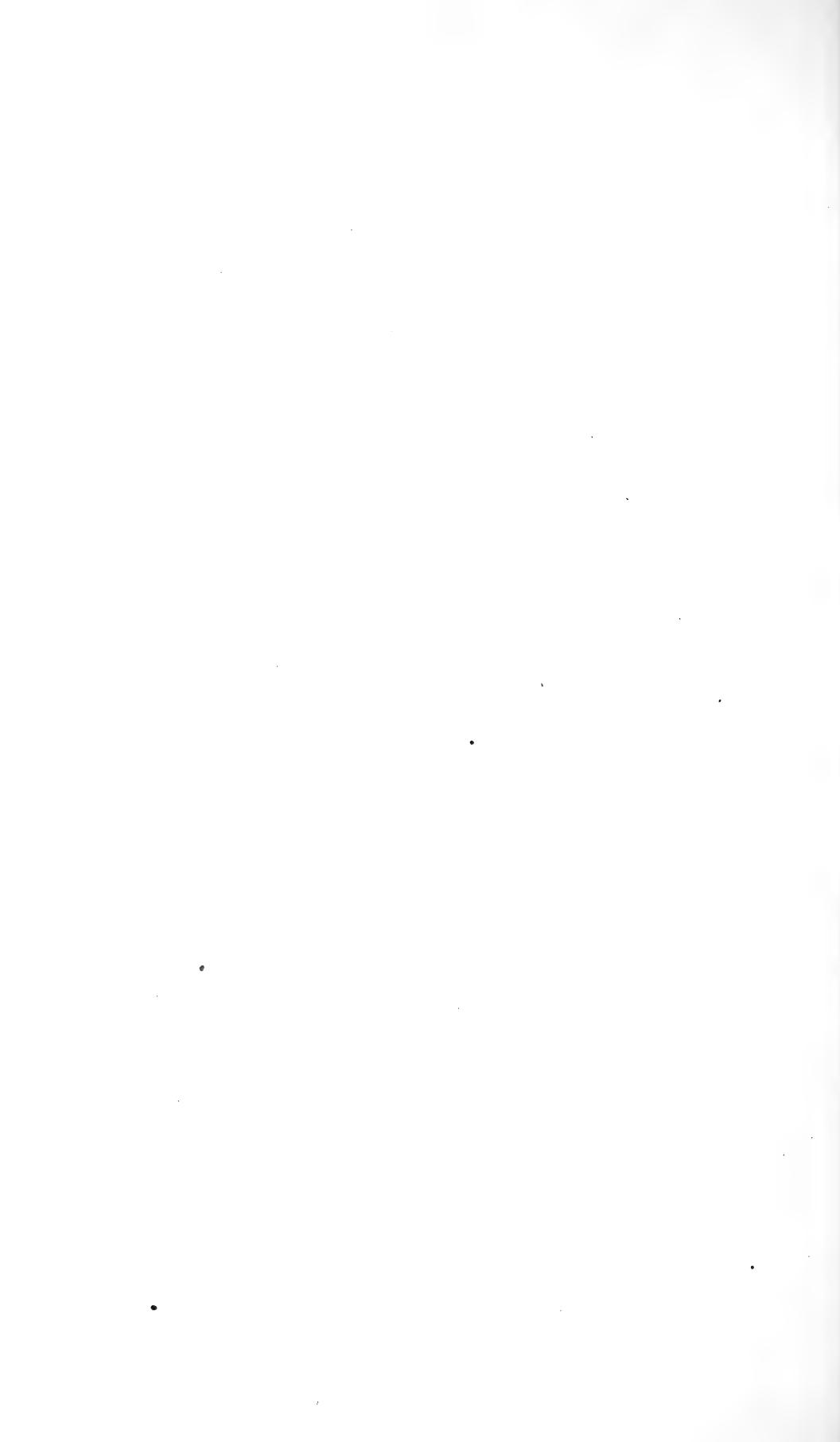
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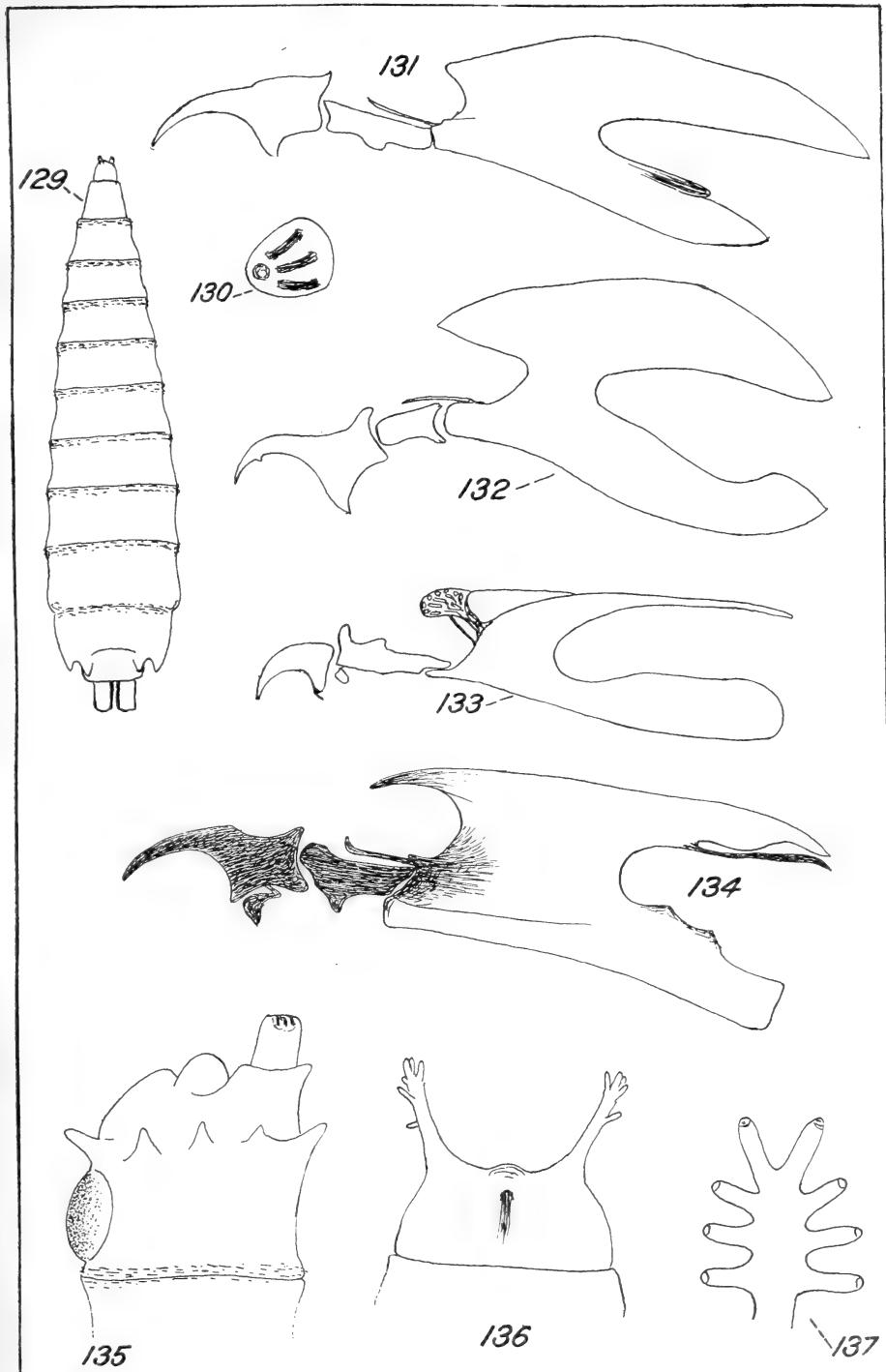




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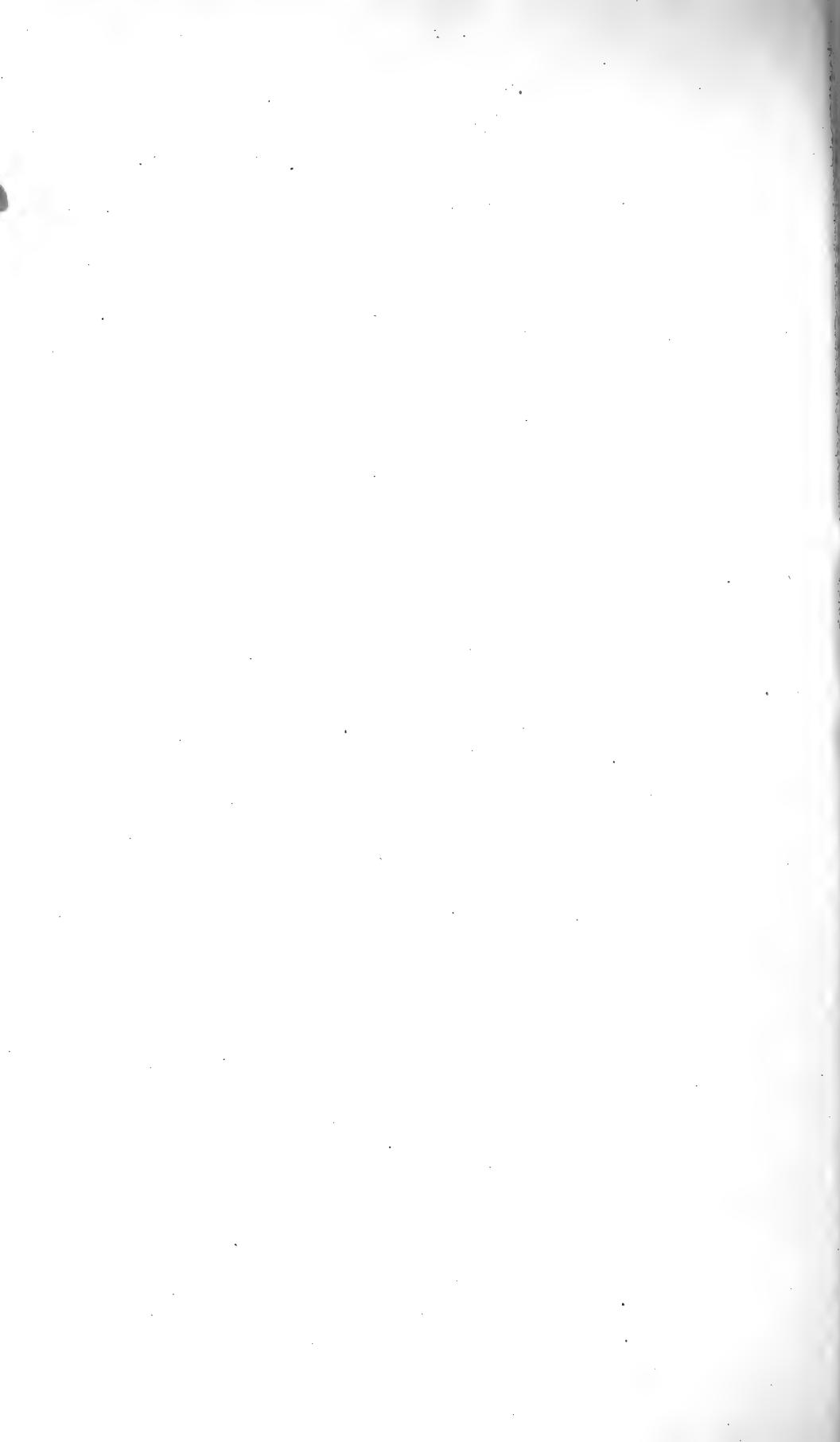
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U. S. DEPARTMENT OF AGRICULTURE,
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L. O. HOWARD, Entomologist and Chief of Bureau.

THE STRUCTURE OF CERTAIN DIPTEROUS
LARVÆ WITH PARTICULAR REFERENCE
TO THOSE IN HUMAN FOODS.

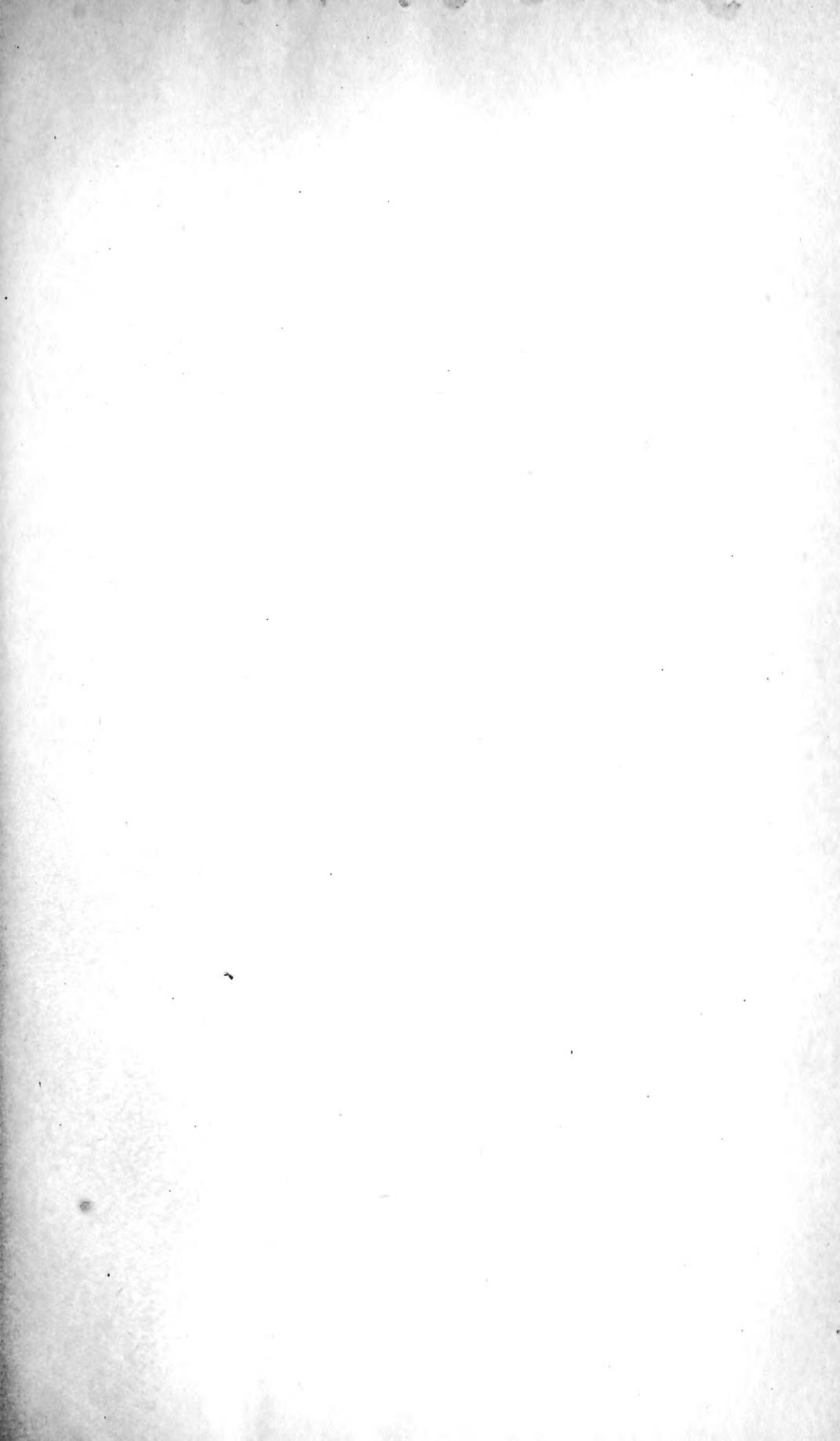
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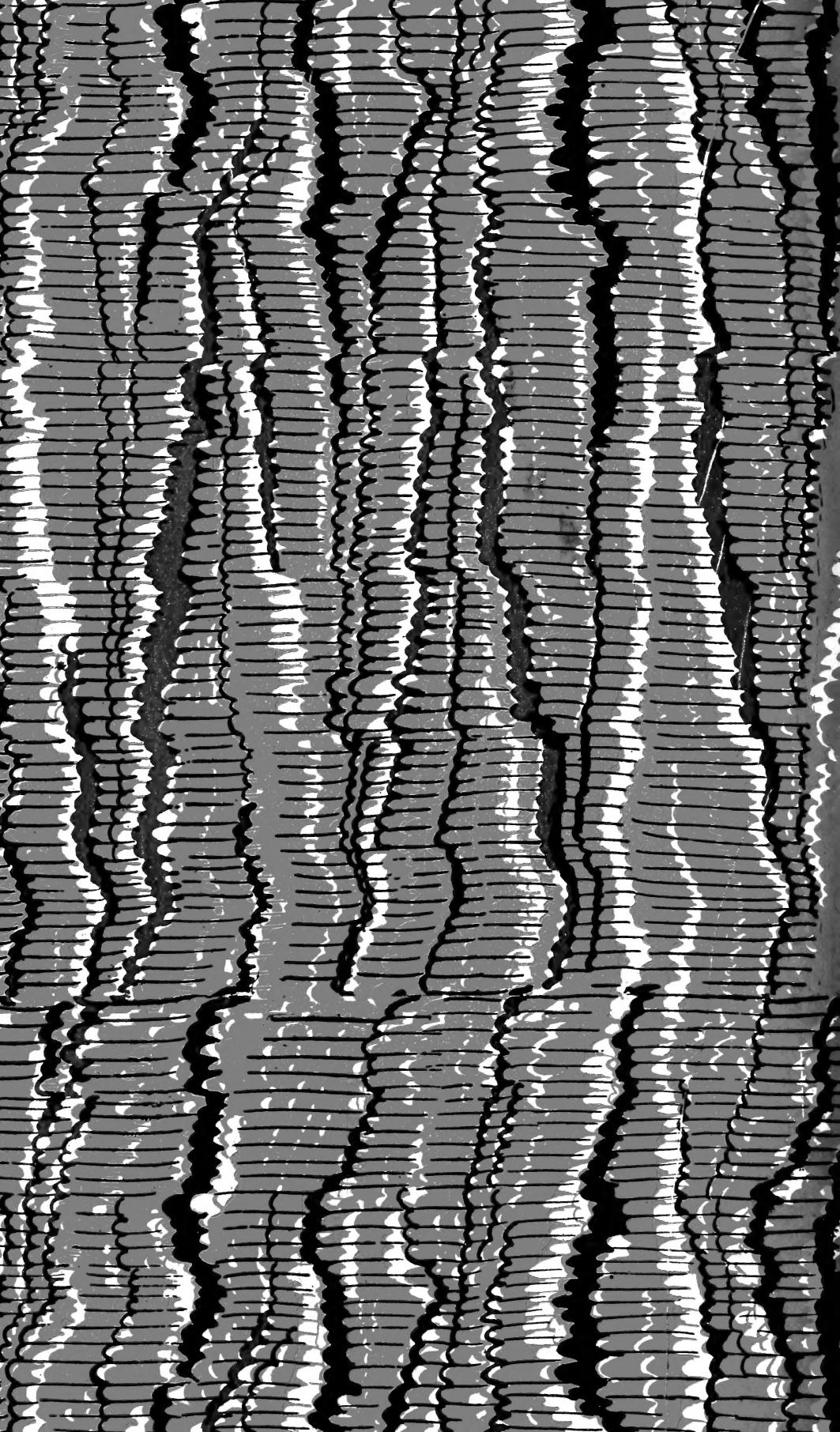
NATHAN BANKS,
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